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DEVELOPMENT OF A METHODOLOGY FOR EVALUATING PRODUCT SERVICE SYSTEM AS A COMPETITIVE STRATEGY FOR THE SINGAPORE MANUFACTURING INDUSTRY

SCHOOL OF APPLIED SCIENCES

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Development of a Methodology for Evaluating Product Service System as a Competitive Strategy for the Singapore Manufacturing Industry

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ABSTRACT

Product Service System (PSS) promotes the idea of selling value in use via an integrated combination of products and services. It has been regarded by many economic policy makers and researchers as a potential competitive strategy for the manufacturing industry in the developed country to gain competitiveness. Although currently there are a few PSS methodologies developed for the design and implementation of PSS, their approach is mainly biased towards using PSS as a tool to gain sustainability and to reduce environmental impact from selling more services instead of selling the physical product for example. In view of this, this research sets out to present a PSS Evaluation (PSSE) methodology, aiming at assisting manufacturer in assessing whether the adoption of a PSS is a good strategy from the point of competitiveness.

The research programme begins with the identification of the requirements set of the PSSE methodology by gaining relevant knowledge from the literature and the Singapore's Manufacturing Industry. Existing potential methodologies were then selected against the requirements set to form the conceptual base of the new PSSE methodology. The developed new PSSE methodology was tested using two case studies during the primary evaluation and another four case studies during the secondary evaluation.

The main contribution of this research is the development of a feasible, usable and useful methodology that can assist the manufacturer in assessing whether the adoption of a new PSS is a competitive strategy. The new seven-stage PSSE methodology provides well-constructed stages which are specially designed to be delivered via a facilitated workshop. This research has therefore made a significant contribution to the knowledge of the concept of PSS, and its application in the manufacturing industry in the area of methodology development.

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Last but not least, to Mr. Hans Kunen, my partner, for his ultimate mental support and encouragement during the final phase of the writing of this thesis.

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GLOSSARY OF TERMS

AMC	Activity Modelling Cycle
B2B	Business to Business
B2C	Business to Customer
BE	
CIRP	College International pour la Recherche en Productique
EDB	Economic Development Board of Singapore
ELIMA	
ERC	Economic Review Committee
ESC	Economic Strategy Committee
ESR	Economic Strategy Review
ES	Eco-efficient Service
EPR	Extended Producer Responsibility
FACTS	Financial, Attitude/Acceptability, Competence/Capability, Technological and Strategic Fit
FP	Functional Product
FS	Functional Sales
GCR	Global Competition Review
GDP	Gross Domestic Product
GNI	Gross National Income
ICT	Information and Communication Technology
IMD	International Institute for Management Development
IMPSS	Integrated Manufacturing and Product Service System
IP	Intellectual Property
IPD	Integrated Product Development
IPS2	Industrial Product Service System
IPSE	Integrated Product and Service Engineering
LCA	Life Cycle Analysis
MCDA	Multi-criteria decision analysis
MEPSS	Methodology for Product Service System
MIPIM	Framework for Business Process Improvement
MTI	Ministry of Trade and Industry
MNC	Multinational Companies
NEA	National Environment Agency
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
PDD	Property Driven Design

PS	Product Service
PSS	Product Service System
PSSE	PSS Evaluation Methodology
PSS-CMC	PSS Competitive Elements Measurement Chart
PSS-SMC	PSS Servitizability Measurement Chart
PSS-CAM	PSS Competitiveness Assessment Matrix
QFD	Quality Function Deployment
ROI	Return of Investments
ROHS	Restriction of Hazardous Substances
R&D	Research and Development
SE	Service Engineering
SIMTECH	Singapore Institute of Manufacturing Technology
SGP	Singapore Green Plan
SME	Small and Medium Sized Enterprises
SWOT	Strengths Weaknesses Opportunities and Threats
QFD	Quality Function Deployment
TRIZ	Theory of Inventive Problem Solving
UK	United Kingdom
UNEP	United Nations Environment Programme
USA	United States of America
V2	Vector 2
WBCSD	World Business Council for Sustainable Development

CHAPTER 1: INTRODUCTION

Product Service System (PSS) promotes the idea of shifting from selling product to selling of value in use via an integrated combination of product and services that can jointly fulfil the needs of the customers (Goedekoop et al., 1999; Mont, 2000; Lamvik, 2001; Oliva and Kallenberg, 2003; van Halen et al., 2004; Abdalla, 2004; Tukker & Tischner, 2006; Kobayashi and Kumazawa, 2006; Baines et al., 2007). It has been regarded by many economic policy makers and researchers as a potential competitive strategy for the manufacturing industry (Wise and Baumgartner, 1999; White et al., 1999; Wong, 2004; William, 2005; Aurich et al., 2006; Lee et al., 2007; Baines & Lightfoot, 2007). This thesis establishes the research within the context of Singapore's Manufacturing Industry, with the aim to explore the viability of adopting PSS as a competitive strategy for manufacturers.

Section 1.1 of this chapter provides a brief introduction to the background of the research programme. Section 1.2 presents the research aim and objectives. The structure of the research programme is presented in Section 1.3, and the contribution and relevancy of this research are described in Section 1.4. The last two Sections give an overview of the structure of this thesis. A chapter summary is provided in Section 1.7.

1.1. BACKGROUND OF THE RESEARCH

Staying internationally competitive is crucial to the growth of the Singapore Economy (ERC, 2002, 2003). Singapore Economy has been performing well in the past few decades and is consistently ranked high by the world competitive reports in recent years (IMD, 2009). Manufacturing has greatly contributed to this phenomenal growth (ERC, 2002; EDB, 2005, 2008; Nah, 2006). It has accounted for close to one quarter of the GDP growth for the past few decades (EDB, 2006a, 2006b). Since Manufacturing is the key driver of the economy, to maintain its competitive edge has become a crucial task for the Singapore Government. Both the Economic Review Committee (ERC) and the Economic Development Board (EDB) of Singapore have recommended the idea of high value manufacturing to maintain its competitiveness (ERC, 2002; EDB, 2005; ESR, 2010). One of the fundamental concepts is to couple high quality products with high value services to develop a knowledge and technology based differentiated manufacturing model that is sustainable and competitive (ERC, 2002; ESR, 2010).

PSS, on the other hand, is a new concept originating from the Scandinavians (Goedkoop et al., 1999; Lamvit, 2001; Mont, 2000, 2004) and focuses in delivering value in use via the combination of products and services (Baines et al., 2007; Baines & Lightfoot, 2007). For manufacturers whose products are commoditized and lacking a differentiating preposition, or having products with a widely installed base that face stiff competition from other low cost and labour intensive economies, PSS presents possible opportunities to create new competitive strategies to sustain further business growth by adding more value to the existing products (White et al., 1999; Oliva and Kallenberg, 2003). As a result, many economic policy makers have been proposing

the use of PSS to increase the competitiveness of the manufacturing industry (Liversey, 2003; William, 2005)

Adopting PSS as a competitive strategy, however, requires the manufacturers to develop new competency to servitize and skill sets to support the delivery of the new PSS. Manufacturers need to undergo organisational changes, both structurally and infra-structurally to support this new servitized movement. As a result, unless manufacturers posses the right capability and ability, and are ready to deliver the potential value promised by a new PSS, its competitiveness cannot be fully exploited.

Hence, the development of suitable tools and methodologies to help manufacturers effectively assess their readiness in providing PSS and the competitiveness of a new PSS strategy is important. Although currently a number of PSS methodologies for designing and implementing PSS exist, they mainly focus towards attaining sustainability and reducing the environmental impact of a new PSS, and their target users are mainly the PSS service providers, and not manufacturers (Goedekoop et al., 1999, 2000; Mont, 2000; Tukker, 2004a; Abdalla, 2004; MEPSS, 2004; Tischner and Verkuijl, 2006).

In view of this, the research sets out to present a methodology that aims to assist the manufacturers in assessing whether the adoption of a PSS is a good strategy from the manufacturing competitiveness point of view.

1.2. RESEARCH AIM AND OBJECTIVES

The aim and objectives of the research are fully described in Section 4.2. The aim of this research is to:

> "Design and evaluate a methodology that will enable the manufacturing companies in Singapore to assess whether the adoption of PSS is a good competitive strategy"

The methodology to be developed in this research is termed as PSS Competitiveness Evaluation (PSSE) methodology. A detailed description of the formation of the PSSE methodology is presented in Chapter 7. The following objectives (Section 4.2) have been defined to deliver the aim of this research programme:

1. Identification of the requirements set of the methodology
2. Evaluation and selection of existing methodology against the established requirements set
3. Formation of a pilot methodology through synthesis of literature and industrial data
4. Evaluation and refinement of the pilot methodology through application in practice
5. Testing the refined methodology through more industrial applications and generation of the final PSSE methodology

1.3. FORMATION OF THE RESEARCH PROGRAMME

The research programme has two principals, namely, Design of Methodology and Validation of Methodology as shown in Figure 1.

1.3.1 Design of Methodology

The "Design of Methodology" Section of the research programme consists of 3 phases designed to address the first three research objectives, namely, to identify the requirements set, to select potential methodologies as a conceptual base and to formulate the structure of the pilot methodology. One of the main research objectives in this section is to understand the requirements of the characteristics set from the literature that contributes a good and practical methodology. It also involves finding out the preferred content and delivery mechanism of the methodology from the Singapore manufacturing industry. The research method used in the first Section of the programme was survey using semi-structured interview and multiple case studies. Results of the execution of this Section are documented in Chapters 5-7.

1.3.2 Validation of Methodology

The "Validation of Methodology" Section of the research programme consists of two phases designed to deliver the last two research objectives, namely, to conduct the primary evaluation of the pilot methodology in a smaller set of companies and to conduct a secondary evaluation of the refined methodology using more industrial cases. The research methods used in this Section are multiple case studies with the researcher acting as the facilitator in the primary evaluation and as an observant/participant in the secondary evaluation. The results of the execution of this Section are documented in Chapter 8 and 9.

1.4. CONTRIBUTIONS AND RELEVANCY OF THE RESEARCH

From the scientific perspective, the primary contribution of this research is the development of the PSSE methodology for helping manufacturers in assessing whether the adoption of a PSS is suitable competitive strategy. The secondary contribution of this research is the development of a PSS framework and facilitation charts which can be used for the assessment of a company's Servitizability (a new term defined in this research; it is defined as the ability of a company to deliver a PSS structurally and intra-structurally), and the competitiveness of the new PSS strategy. Detailed description of the research contribution can be found in Section 10.2 & 10.3.

From the Singapore manufacturing perspective, this research is in line with the Singapore Government intention in growing the manufacturing sector to high value manufacturing. The PSSE methodology developed in this research will be particularly useful in providing guidelines to the manufacturers who wish to look into the possibility of implementing PSS as a competitive strategy. As PSS is relatively unknown in Singapore, this research has also helped to create awareness of this new concept to the Singapore's manufacturers and the corresponding policy makers.

1.5. STRUCTURE OF THE THESIS

Chapter 1 presents the background of the research. It describes the research aim and objectives, and discusses the formulation of the research programme. The structure of the thesis is also outlined in this chapter.

Chapter 2 provides an overview of the Singapore Manufacturing Industry and highlights the industrial problems and challenges it faces.

Chapter 3 provides a detailed literature review of the concept of PSS. It discusses the definitions and features of PSS, existing tools and methodologies, the role of PSS within Servitization and PSS as a competitive strategy for the manufacturers.

Chapter 4 presents the aim and objectives of this research and describes the structure of the 5-phase research programme designed to deliver the research aim and objectives.

Chapter 5 describes the execution process and results of the first phase of the research programme. It first presents the results gained from the literature concerning the characteristics of a good and practical methodology. It then discusses the formulation of the data collection protocol designed to solicit opinions from the Singapore industry concerning the delivery mechanism and content of the PSSE methodology, by presenting the key findings of the ten industry cases. The final requirements set of the PSSE methodology is provided at the end of the chapter.

Chapter 6 presents the second phase of the research programme by reviewing existing methodologies against the requirement sets outlined in Chapter 5. Three potential methodologies were selected, in which there were two from the category of manufacturing strategy and one from the category of PSS methodology.

Chapter 7 presents the third phase of the research programme by discussing the formulation process of the structure of the pilot PSSE methodology. It also discusses the set of new tools specifically redeveloped for the PSSE methodology.

Chapter 8 discusses the execution of the fourth phase of the research programme. It presents the executive process and results of the primary

evolution of the pilot PSSE methodology using two case studies from the Singapore industry.

Chapter 9 presents the final phase of the research programme. It describes the execution and results of the secondary evaluation of the refined PSSE methodology using four case studies from the Singapore industry. It also presents the final structure of the PSSE methodology.

Chapter 10 presents the conclusion of this research. It discusses the research contributions and limitations, and proposes recommendations for further research.

Appendix A provides all the questionnaires used to conduct the semi-structured interview and the post-assessment of both the primary and secondary evaluation PSSE workshop. The structure of the final PSSE methodology is presented in the form of a facilitator's guide and is included in Appendix B. Appendix C contains the case studies of the PSSE methodology and the results of the post assessment of the PSSE workshop can be found in Appendix D.

1.6. CHAPTER SUMMARY

This chapter has provided a brief overview of the research programme and has described the structure of the research programme and thesis. The next chapter will discuss the industrial problems of the Singapore manufacturing industry.

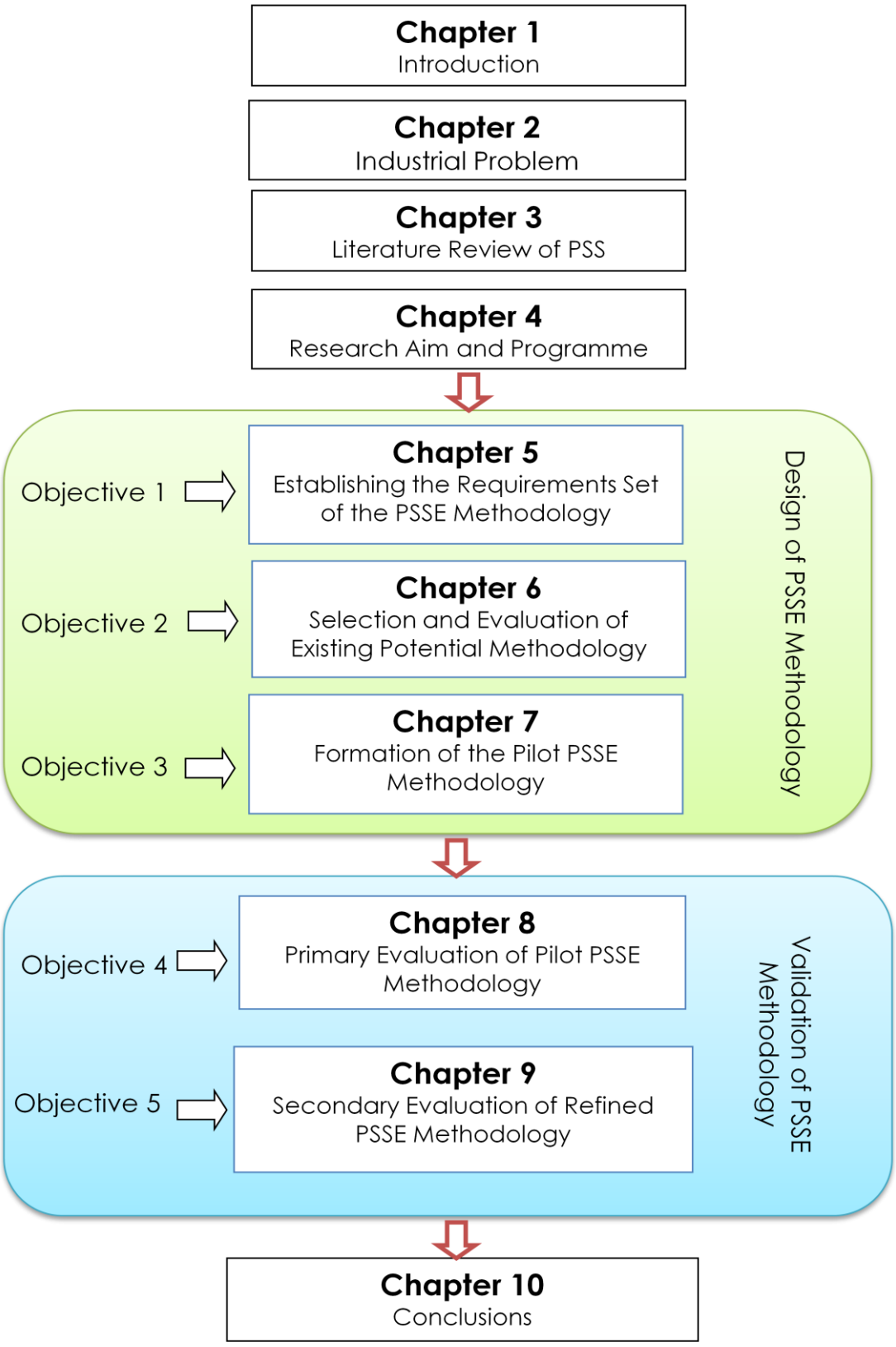


Figure 1: The Overall Structure of the Thesis

CHAPTER 2: INDUSTRIAL PROBLEMS

Chapter 1 provides a brief introduction to the background of the research, its aim and its contributions. Chapter 2 deals with the industrial context of the research. Section 2.1 provides a detailed description of the important roles played by the manufacturing and service sectors within the Singapore Economy. Section 2.2 highlights the current environmental challenges faced by the small state country in sustaining economic growth through manufacturing and services, and presents the Singapore Green Plan 2012. Section 2.3 provides a summary of the main concerns faced by the manufacturing industry and presents a case for this research programme.

2.1. OVERVIEW OF SINGAPORE ECONOMY

Singapore is a small state country with very little natural resources. As a result it needs to maintain international competitiveness and *joie de vivre* as the fundamental principles of its economy. For the past decade, Singapore has been ranked as one of the world's most competitive nations in terms of economic growth and overall competitiveness. Figure 2 shows a comparison of the growth of Real Gross Domestic Product (GDP) per capita of Singapore against other countries in the world.

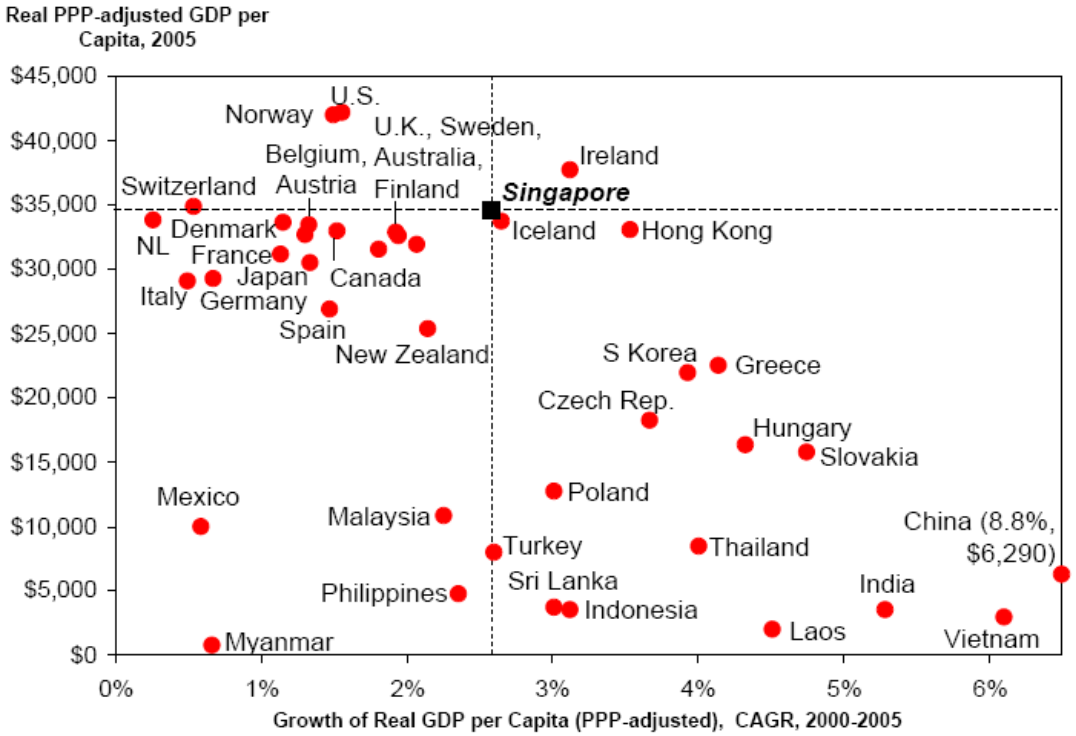


Figure 2: Comparison of Growth of Real GDP per Capita (Selected Countries)

Source: Porter (2005)

In terms of overall world competitiveness, the Global Competitiveness Report has ranked Singapore in third position, just behind Switzerland and United States in 2009 (GCR, 2009). Singapore has also managed to remain in the top three positions since 2005 as ranked by the World Competitiveness Year Book (IMD, 2009). The overall global competitiveness scorecard is calculated based on competitiveness factors like infrastructure, innovation, technology readiness, business sophistication, macroeconomic stability and education etc.

Since its independence in 1965, Singapore has enjoyed spectacular economic growth. The per capita GNI in 2009 reached S$ 51,860, which is thirty two times the level in 1965 (Singstat, 2010). As shown in Figure 3, the GDP of Singapore in 2009 was S$235 billion (EDB, 2009), an increase

of over twenty five percent growth from the year 2005 of S$194 billion, and multiplying by an astonishing one hundred and ten times compared to a humble insignificant low of S$2.15 billion GDP produced in 1960 (Singstat, 2010).

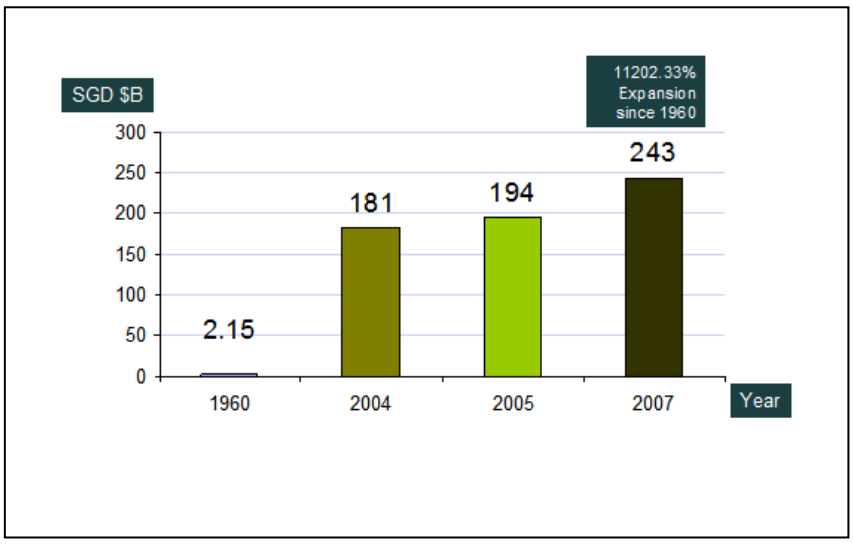


Figure 3: Gross Domestic Product (GDP) Growth for the Singapore Economy from 1960-2007

Source: Singstat (2010); EDB (2009)

The Singapore economy has been resilient and robust. It has successfully bounced back and rebuilt its economy from a series of economic crises like the Asian crisis in 1997-98, the bursting of the dot.com bubble in 2001, the outbreak of SARS in 2003, as well as the more recent worldwide financial meltdown in 2008-2009. Although now able to regain its strong foothold after each crisis, Singapore is facing harder challenges in transforming its economy into a globalized and diversified economy in order to sustain its international competitiveness.

2.2. OVERVIEW OF SINGAPORE MANUFACTURING INDUSTRY

Manufacturing has accounted for more than one quarter of the GDP growth in the past few years (Nah, 2006). As shown in Figure 4, except for 1999 and 2001, manufacturing has gorwn steady for the past seventeen years. In fact, for the last ten years, the growth of the manufacturing sector has excelled the growth of the GDP, outperforming the business and financial services, retail, transport and communications sectors (MTI, 2008). The manufacturing sector has thus contributed tremendously to the phenomenal growth of the Singapore economy.

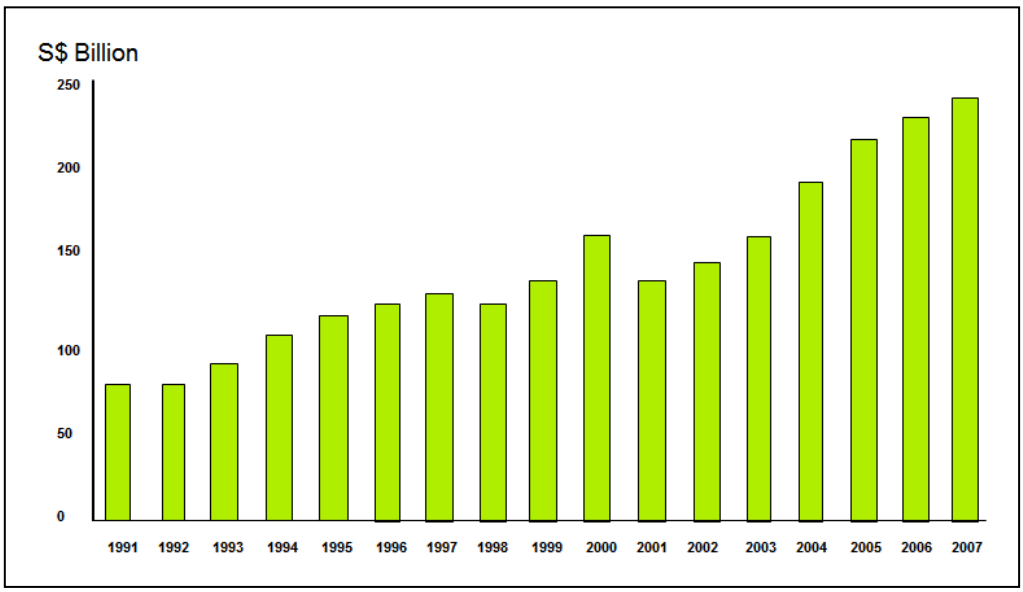


Figure 4: Performance of the Manufacturing Sector, 1991 – 2007

Source: MTI (2008)

Since Manufacturing is the key driver of the economy, the Singapore Government is determined to keep it as one of the main pillars of the country's economy. The Economic Development Board (EDB) of Singapore has set goals for sustaining the future of Singapore's

manufacturing industry. One of the goals is to increase the overall manufacturing output to $300 billion and to raise the skill profile from 30% in 2003 to 50% by 2018 (EDB, 2005). The growth of Singapore manufacturing has been consistently strong, and by 2006 the total output had already reached $227 Billion (EDB, 2006b). This is on course and is likely to bring forward the target year of 2018 set by EDB to reach the $300 billion goal for total manufacturing output.

To sustain the buoyant growth of the manufacturing sector and to prepare for the foreseeable challenges in the future, Singapore, like many of the developed countries in the West, is gradually shifting from low value; labor intensive manufacturing, to high value manufacturing to sustain its competitiveness. In the year 2002 the Economic Review Committee (ERC) proposed to establish Singapore as a global leader in value manufacturing (ERC, 2002). To realise this goal, the committee emphasised the importance of tranforming Singapore into "an innovative creator of products and new businesses", with the intention of steering Singapore away from the image of an "efficient producer of products".

High order products, coupled with high value services, are set to create a knowledge-and-technology based manufacturing model, which is more sustainable and competitive. The concept of high value manufacturing is aimed to develop new capabilities in product and services that can span throughout the entire product life cycle, which is illustrated in Figure 5 (ERC, 2002, 2003). High value manufacturing involves the exploration and exploitation of values generated from the downstream value chain activities. One of the options of such exploitation is to provide value add product-service to the customers.

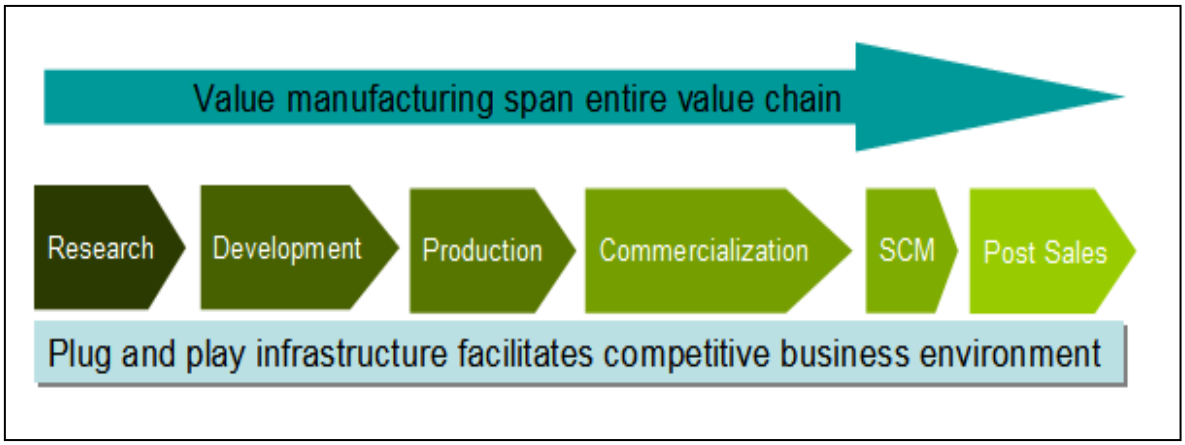


Figure 5: The Concept of High Value manufacturing

Source: ERC (2003)

2.2.1 The Growth of Manufacturing and Services

Service is expected to play a much more important role in the future of Singapore economy, by contributing to the performance of the Singapore manufacturing. From 2005-2008, about 65% of the total business spending in Singapore for services was related to manufacturing (MTI, 2008).

Figure 6 provides a glimpse of the manufacturing and services sectors performance over the past thirty years. The service sector performance is relatively more stable when compared to the manufacturing performance; therefore it is often regarded as a cushion to absorb the vibrancy and fluctuation of the growth of the manufacturing sector. This is especially true during the period of economic downturns or economic slowdown in other developed countries, where the Singapore manufacturing sector is relied upon heavily for its export.

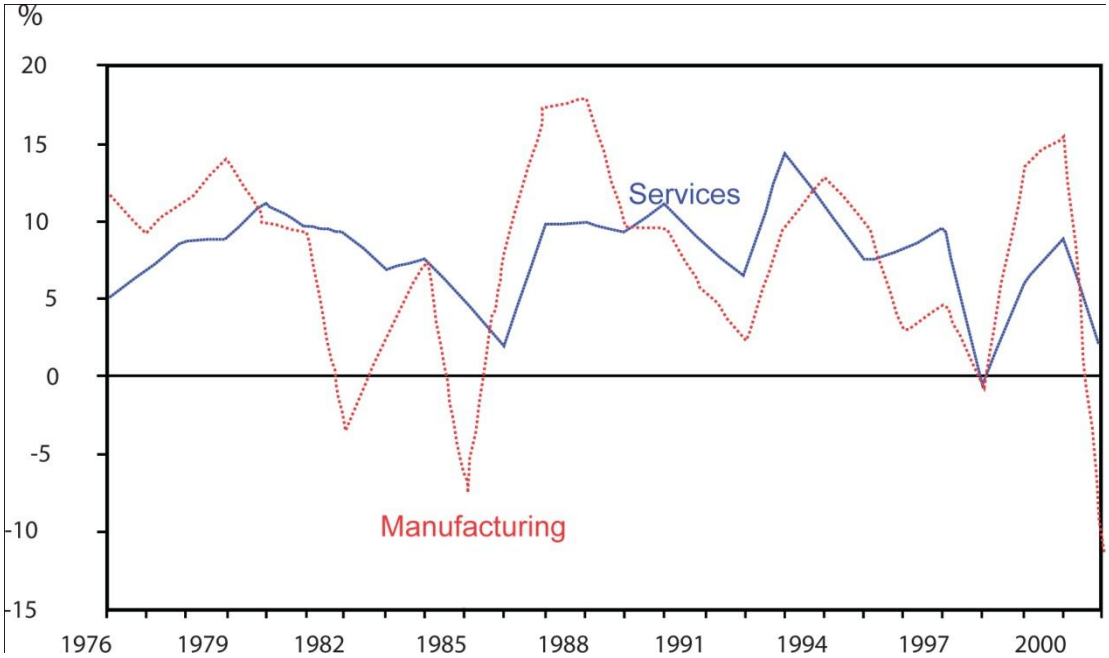


Figure 6: Manufacturing and Services Growth

Source: MTI (2006)

In principle, a strong service sector is more likely to make the entire economy and manufacturing sector more robust and competitive. Many developed countries have already been actively growing their service sector in order to help sustain their economic growth. According to the OECD Historical Statistics, the services' share of GDP and employment of the leading economies in the world like US, UK, France, Japan and Germany have been increasing steadily from 1960 to 1995, as shown in Figure 7.

As a result, building both the manufacturing and service sector has always been one of the key strategies in the reform of the Singapore economy (ERC, 2002). In 2006, the Economic Development Board of Singapore stressed the importance of establishing the manufacturing and service sectors as the twin pillars for the future growth of the Singapore economy [EDB, 2006a] with the hope that this dual trust will help Singapore to establish a more resilient economy. In addition, as

service carries less tangle components it is also often regarded as a solution of dematerialization.

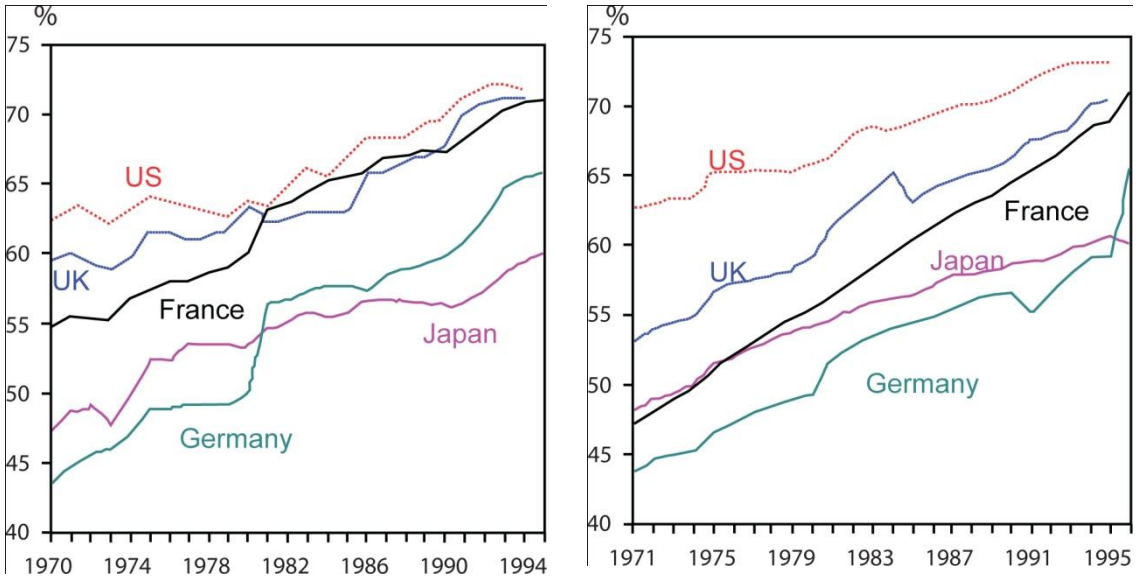


Figure 7: Services' Share of GDP in the developed countries

Source: OECD Historical Statistics, 1960-1995

Singapore government has recently released its latest proposal put forward by the Economic strategic committee (ESR, 2010). In it, one of the key recommendations is to grow manufacturing-related services by captivating on the synergy and a convergence of the manufacturing and services, to provide services in the areas like product lifecycle management, headquarter-related activities, R&D and Intellectual Property (IP) management. The aim is to retain a globally competitive manufacturing industry at a growth rate of 20-25% of the economy and convergence of manufacturing and service has been identified as a key driver to achieve this mission.

2.2.2 The Environmental Challenges for Singapore Manufacturing

Being a small state country the lacks resources, Singapore has long been constantly facing steep challenges in preserving its natural resources like water and energy. Buoyant manufacturing growth and economic activities will inevitably bring forth a negative impact on the environment (NEA, 2005). To stay internationally competitive, Singapore have to ensure that its manufacturing industry meets the increasingly stringent demands of environmentally friendly products from organisations and consumers internationally. Hence, while putting efforts into growing the manufacturing and service sectors, Singapore has to make sure that it does not strain its environment and is able to provide its citizens with a clean and green living environment.

In the Chinese New Year speech given on 23 February 2007, the former Prime Minister of Singapore set forth a new benchmark for Singaporeans to achieve - an inspiration for Singapore to move up to the first half of the first world in the next 10 to 20 years together with a green and vivid vision for our living environment:

> *"The next stage after a clean and green Singapore is a vibrant city with clean waters and garden everywhere, this will be done in your life time."*
>
> *-- Mr. Lee Kuan Yew, (Today, 2007)*

In the year 2002, the Singapore government drafted the blue print of the Singapore Green Plan 2012 - SGP 2012, as a basic guide for environmental sustainability (NEA, 2003; NEA, 2005). One of the aims of SGP 2012 is to close the waste loop by the year 2012 through the improvement of the Singapore recycling system and infrastructure. In the aspect of manufacturing, Extended Producer Responsibility (EPR) has

been mentioned in the report as one of the key strategies that could possibly help to reduce industry waste. EPR is an environmental policy tool that holds the manufacturers accountable for the social cost of waste management. It encourages manufacturers to implement product take back at the end of the product life cycle as well as to reuse and recycle the material or used parts.

2.3. THE MAIN INDUSTRIAL CONCERNS OF SINGAPORE MANUFACTURING INDUSTRY

For the last 20 years, fuelled by the booming economies of the United States and Southeast Asia, Singapore has been able to benefit from its unique position as a low-cost-high-quality manufacturing hub. In recent years, as shown in Figure 5, the growth has been declining. The reason is that apart from being affected by the global financial crisis that was triggered by credit crunch in USA and Europe, Singapore is also facing fierce competition from the low cost developing Asian countries like India, China and Vietnam. Singapore is still able to maintain its competitive edge through actively developing its manufacturing industry through R&D and attracting more big MNCs to set up their hi-tech manufacturing facilities. However, as economic contests are becoming more intense, with the neighbouring countries upgrading their infrastructure and skill set in the workforce, Singapore has to move up the value chain to maintain its competitive edge by moving towards high value manufacturing through the development of new capabilities and strategy by growing manufacturing and services:

- Developing more high value products
- Developing high manufacturing value chain for these products by offering more high value services

- Last but not least, Singapore needs to take care of the environment while growing its manufacturing industry

In short, the manufacturing industry of Singapore needs to address the following two challenges:

- Continue to sustain the growth of the manufacturing industry
- Develop high value service sectors to support the growth of the manufacturing industry

The World Business Council for Sustainable Development has identified four important elements of eco-efficient manufacturing, namely, dematerialization, closing production loops, service extension and functional extension (WBCSD, 1996). Hence, the move of manufacturers towards providing a more value added service and functional extension can also be seen as a long term sustainable solution of the Singapore manufacturing industry.

In summary, to sustain long term competitiveness, Singapore needs to constantly look out for sustainable business strategy to develop a high value added manufacturing system that is capable of linking manufacturing, services and environment into a long term sustainable competitive economic model.

2.4. CHAPTER SUMMARY

This chapter has provided an overview of Singapore's economy and the manufacturing industry. It has highlighted the role of services in the growth of the manufacturing industry, as well as Singapore's intention to grow both the service and manufacturing sectors in order to maintain the competitiveness of Singapore's economy. The challenges faced by the Singapore manufacturing industry were also discussed. The next chapter presents the results of the literature review of this research.

CHAPTER 3: LITERATURE REVIEW

Chapter 2 discussed the industrial problem and highlighted the importance of manufacturing industry to the Singapore economy. It also discussed that in order to sustain its long term competitiveness; Singapore needs to move towards high value manufacturing to adopt solutions that can effectively link manufacturing, services and environment into a sustainable competitive strategy. Chapter 3 presents the literature review of PSS, a concept which has been suggested by many researchers and policy makers as a potential solution that is able to address the above mentioned problems (Goedkoop et al., 1999; UNEP, 2002a, 2002b; Mont, 2004; van Halen et al., 2005; Livesey, 2003; William, 2005; Tukker & Tischner, 2006; Baines et al., 2007).

The structure of the literature review is illustrated in Figure 8. The definitions of PSS and the definition of terms relating to the concept of PSS are provided in Section 3.1. Type of PSS and its classification are then discussed in Section 3.2. Section 3.3 gives an overview of the existing tools and methodologies related to PSS, and Section 3.4 examines the role of PSS as a competitive strategy for manufacturing. Section 3.5 provides an overview of the current research issues, and a chapter summary is presented in Section 3.6.

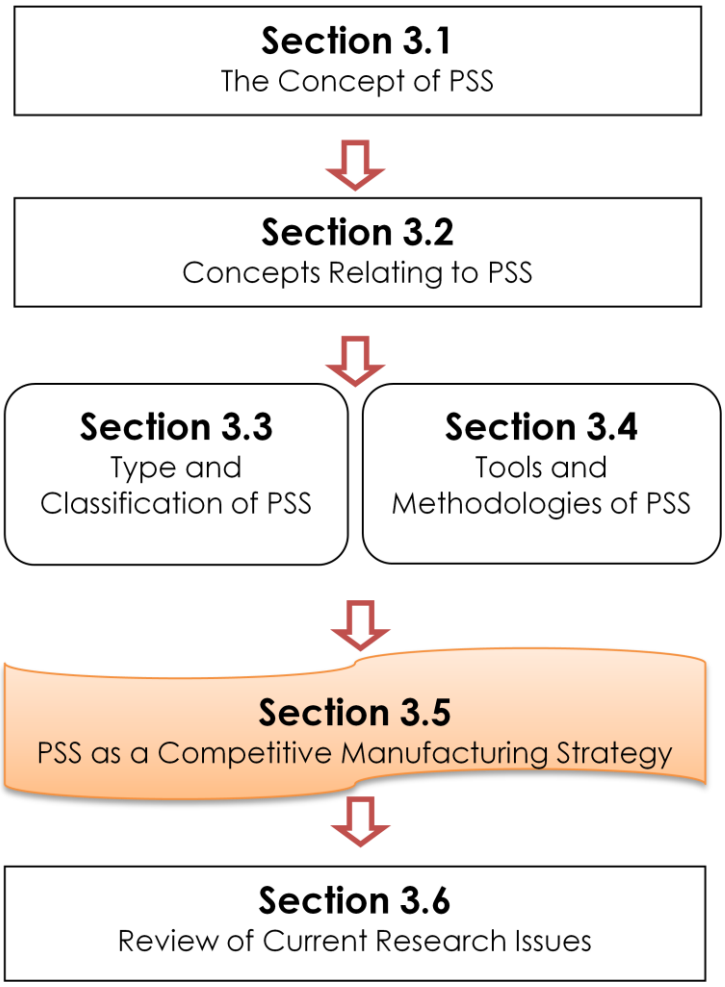


Figure 8: Structure of the Literature Review

3.1. THE CONCEPT OF PSS

3.1.1 History and Evolution of PSS

The concept of PSS originates from the Scandinavians in the late 1990's and has its roots in industrial ecology, with the aim of reducing the consumption of materials and improving sustainability (Goedkoop et al., 1999; Lamvit, 2001; Mont, 2000, 2004). Since its inception in 1999, PSS has been capturing attention from academia (Charter, Admas & Clark, 2004; Baines et al., 2007; McAloone, 2006; Manzini, 2001, 2003), product designers (Morelli, 2003; Tukker, 2003, 2004a; Bartolomeo, 2003), economists (Morey, 2003; Jalas, 2005; Scholl, 2006) and policy makers (UNEP 2002a, 2002b; Livesey, 2003) etc.

Many researchers regard PSS as a potential solution that is able to reduce adverse environmental impact due to the fact that it promotes functional selling to meet the customer's needs rather than the physical product per se (Lamvik, 2001; Manzini, 2003; Mont, 2004,). According to the United Nations Environment Programme (UNEP), PSS has the potential to establish a service economy that is less materialized and environmentally friendly (UNEP, 2002b).

On the other hand, more and more researchers in recent years see the potential of PSS as a competitive strategy to manufacturers (Goedkoop et al., 1999; White, Stoughton & Feng, 1999; Oliva & Kallenberg 2003; Baines & Lightfoot, 2007; Baines et al., 2009). Goedkoop et al. emphasize the role of PSS as a potential source for growing business with high added value. By moving downstream, a PSS may improve the strategic positioning of a company because of the potential added value incentives generated through the provision of a product services mix

solution. Especially in a mature market, PSS can be the key to add value and diversification (Oliva & Kallenberg, 2003; Baines et al., 2009).

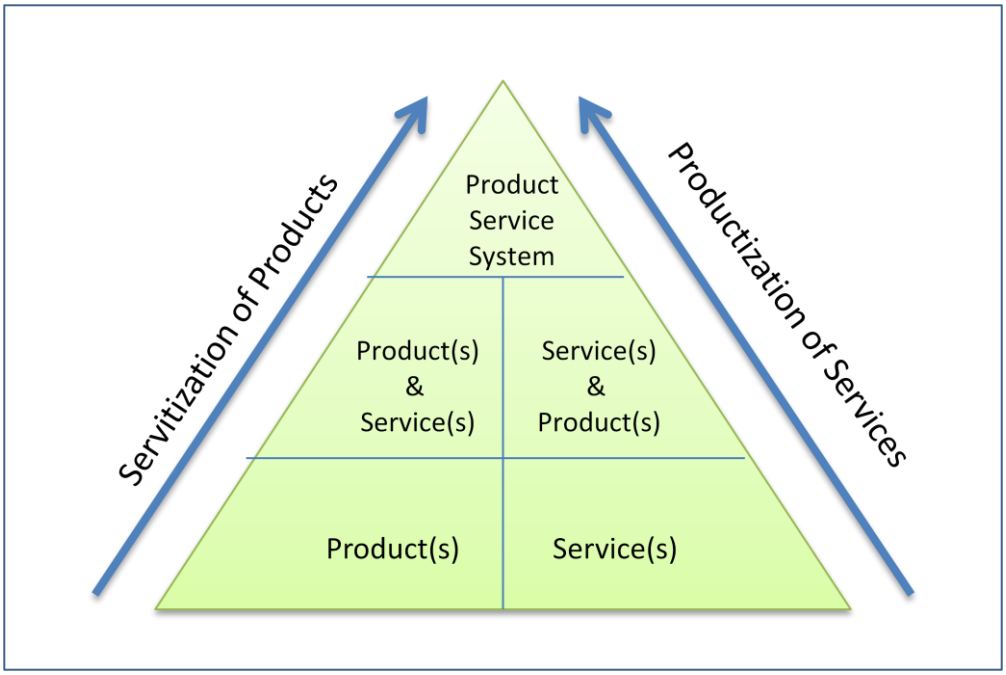


Figure 9: Evolution of PSS

Source: Baines et al. (2007)

3.1.2 The Definition of PSS

The earliest definition of PSS was given by Goedkoop et al. in 1999 who define PSS as "a marketable set of products and services capable of jointly fulfilling a user's need". Goedkoop et al. outline the basic elements that form a PSS, namely; Product, Service, Networks of 'players', Supporting Infrastructure, Competitiveness, Customer Needs Satisfaction and Lower Environmental Impact (Goedkoop et al., 1999). This definition was later endorsed by the Dutch Policy Document on Environment and Economy in 2000 (Goedkoop, Spriensma & Effting, 2000).

Mont (2000) expands the definition to cover the system aspect and redefines it as "a system of products, services, networks of actors and supporting infrastructure that is developed to be; competitive, satisfy

customer needs and have a lower environmental impact than traditional business models" (Mont, 2000).

Manzini et al. (2001) describe PSS as "a result of an innovative strategy, shifting the business focus from designing and selling physical product only, to selling a system of products and services which are jointly capable of fulfilling specific client demands" (Manzini et al., 2001). This definition was adopted by the United Nation Environment Programme in 2002 (UNEP, 2002b).

Table 1 provides a summary of the PSS definitions available in the literature. In summary, most of the definitions cover the key elements that form the concept of PSS such as product, service, network partners, supporting infrastructure, fulfilling customer needs, generating customer satisfaction, creating competitiveness, and producing less environmental impact.

In this research, the definition of PSS proposed by Baines et al. (2007) will be adopted:

> "PSS is an integrated combination of products and services that delivers value in use"
>
> *-- Baines et al., 2007*

3.1.3 Definitions of Terms Relating to PSS

This section provides the general definitions of the basic terms that are used in defining PSS. Terms like "product" and "service", although appearing to be easily understood varying in definition from the literature of marketing to manufacturing (Goedkoop et al., 1999).

Table 1: The Definitions of PSS

Author	PSS Definition
Baines et al., 2007	"PSS is an integrated combination of products and services that delivers value in use"
ELIMA, 2005	"A system of products, services, supporting networks and infrastructure that is designed to be competitive, satisfying customer needs, & having lower environmental impact than traditional business models"
CIRP, 2007	"IPS² - Industrial Product Service System, is a new product understanding consisting of integrated product and service shares"
Wong, 2004	"A solution offered for sale that involves both a product and a service element, to deliver the required functionality"
Mont, 2004	"A system of products, services, networks of actors and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and has a lower environmental impact than traditional business models"
Manzini et al., 2001	"Product-Service System can be defined as the result of an innovation strategy, shifting the business focus from designing and selling physical products only, to selling a system of products and services which are jointly capable of fulfilling specific client demands"
Goedkoop et al., 1999	"A marketable set of products and services capable of jointly fulfilling a users' need"

Product

In the context of manufacturing, a product is usually regarded as something tangible, and does not contain any intangible service elements. For example, a car, an engine or even small component parts being manufactured like screws and nuts. However, in the context of marketing, the term product can be referring to intangible products such as insurance policy package or services rendered to the customers. Vargo and Lusch regard product (or Goods) as embedded knowledge used by the customers in the value creation process (Vargo & Lusch, 2004).

In this research, the following definition of 'Product' described by Goedkoop et al. was adopted:

> "Product is a tangible commodity manufactured to be sold, and of capable of falling on your toe and fulfilling a user's needs"
>
> - Goedkoop et al. (1999)

Service

Hill (1987) defines service "as a change in the condition of a unit or a person, or of a good belonging to some economic unit, which is brought about as a result of the activity of some other economic unit, with the prior agreement of the former person or economic unit". Kotler (1989) suggest that "a service is not a physical thing but rather energy expenditure". Many researchers in the manufacturing community have also commented that the line between product and service is getting blurred (White et al., 1999; Wise and Baumgartner, 1999; Wong, 2004). They argue that it is unlikely to arrive at a definitive list of factors that can be used to distinguish products from services.

Service, in the context of manufacturing, normally refers to an offering provided to the customer (Baines et al., 2008). For example, services provided by a manufacturer to a B2B customer like training and consultancy, or to a B2C customer, such as installation and warranty. According to Goedkoop et al. (1999), "a service is an activity done for others with an economic value and often done on a commercial basis. It is what you can buy or sell, but that is not capable of falling onto your feet".

Although in most cases, services involve the handling of physical products, service itself, however, does not necessarily result in the transfer of the ownership of the products to the customer. Services, in general, are add-on economic activities that help the manufacturer to ensure that the product being sold, either on its own or in a bundle, is able to operate in good condition and deliver its intended functionality. Therefore, in this research, service is defined as:

> "An economic activity that does not result in ownership of a tangible asset"
>
> - Baines et al., 2007

Value in Use

In the context of marketing, "Value in use" is a concept proposed in "Service-Dominant Logic" - a new marketing paradigm that moves away from the old "Goods-Dominant Logic", and has been defined as "value co-created with customer" (Vargo and Lusch, 2004). Levitt (1980) believe a customer will attach value to a product or service in proportion to its perceived ability in helping to solve his problems or fulfilling his needs (Levitt, 1980).

In this research, the following definition of "Value in Use" has been proposed:

> "The value of the utility of an integrated combination of products and services delivered by PSS to a customer"

3.2 GENERAL CONCEPTS RELATING TO PSS

This section provides a brief description of the concepts that are relating to PSS in general. As shown in Table 2, concepts relating to the inception and evolvement of PSS can be briefly classified into four main categories, namely, the concept of Servitization and Servicising, the concept of functional sales and economy, the concept of integrated product and service offering and the concept of eco-efficient services.

3.2.1 The Concept of Servitization and Servicising

The first category of concepts is concerned with the increasingly common phenomenon of manufacturers moving away from selling physical products to selling a system of product and services to gain competitive advantages. The first concept, Servitization, was first proposed by Vandermerwe and Rada (1988) in their article entitled "Servitization of business: adding value by adding services" (Vandermerwe and Rada, 1988). Vandermerwe and Rada see Servitization as "a movement in which companies consciously drive their businesses into services to gain competitive ground". This concept was subsequently adopted by Baines et al. to refer to the phenomenon of manufacturers shift from selling of products to the selling of PSS (Baines & Lightfoot, 2007; Baines et al., 2008).

White et al. in 1999 used the term "Servicing" to describe "the emergence of product-based services which blur the distinction

between manufacturing and traditional service sector activities" (White et al., 1999).

3.2.2 The Concept of Functional Sales and Functional Economy

The concept of Functional Sales and Functional Economy is established upon the notion that customer's need can be met by providing the function they required rather than the product per se (Stahel, 1999; White et al.,1999; Mont, 2002; Wong, 2004). Functional sales focuses on offering the functional solutions, which consists of a combination of systems, physical products and services, from a life-cycle perspective that are able to fulfil a defined customer need (Sundbo, 1994; Mont, 2002; Sundin et al., 2005, 2006; Lindahl, 2006b; Östlin et al., 2006). According to Stahel (1999), functional economy is an economy, that is able to optimise the use, or function of goods and services (delivered via functional sales), and therefore the management of existing wealth of goods, knowledge, and nature (Stahel, 1999). Mont (2002) believes that the basic principle of PSS is developed upon an overall idea of a functional economy and eventually will evolve into a functional –based society.

3.2.3 The Concept of Integrated Product and Service Offering

The concept of Integrated Product and Service Offering lies beneath the concept of integrated product and offering category. A few related terms exist in this category, namely, Service Engineering (which proposes to deal with services in an engineering manner) (Bullinger, 2003; Sundin et al., 2006; Sakao & Shimomura, 2007), Integrated Product and Service (Windahl et al., 2004), and Integrated Product and Service Engineering (IPSE) (Sundin et al., 2005; Lundahl et al., 2006a). IPSE evolved from the concept of Service Engineering and Functional Sales and has it origin from the life-cycle based interactive model.

Services are being viewed as part of the customer offerings; as a result, it is proposed that the design of the services should start right from the beginning of the design phase together with the products. For manufacturing companies, who traditionally focus only on the design and development of physical products, this brings forth challenge and needs to change and improve their organisational process to support the new product service development right from the beginning.

3.2.4 The Concept of Eco-efficient Services

The concept of eco-efficient services advocates that functions delivered by a service, while creating maximum added value for the customers, should be able to produce minimum environmental impact and use of resources (Heiskanen, 2000; Brezet et al., 2001; Engelhardt, 2002). According to Brezet et al., eco-efficient services can be regarded as the deliberate development of a new PSS or the redesign of an existing PSS, aiming at producing minimum environmental impact within every unit of value in use delivered.

Figure 9 shows the time lines of the evolution of the concepts relating to PSS.

This section has discussed the definition of PSS and the terms used in its definition such as Product, Service and "Value in Use". It has also discussed the concepts relating to PSS in general. In the next section, the type and classification of PSS will be discussed.

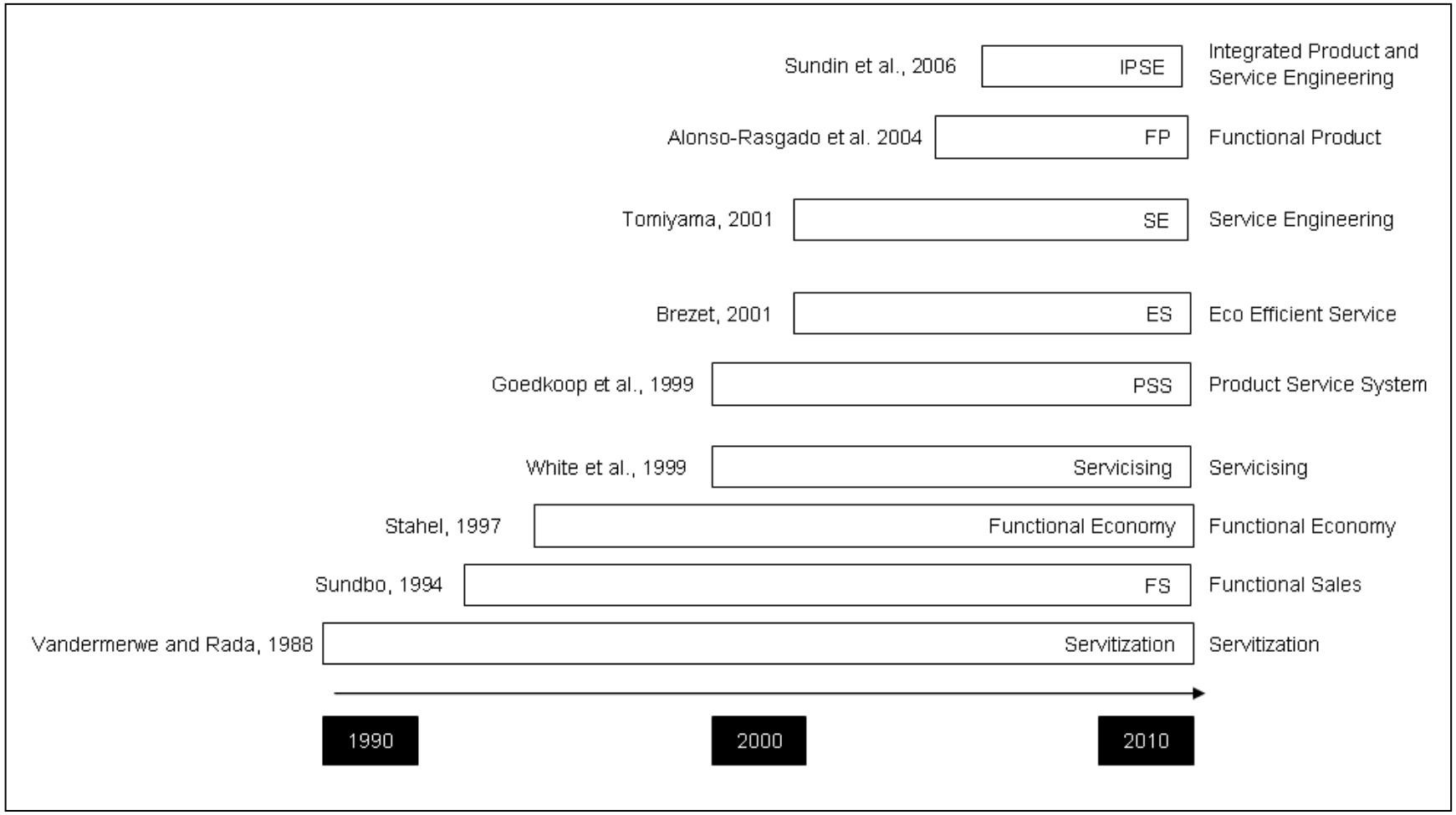


Figure 10: Timelines of the Evolvement of the Concepts Related to PSS

3.3 TYPE AND CLASSIFICATION OF PSS

3.3.1 Types of PSS

Apart from the many definitions from various research communities, many different types of PSS have been proposed too (Roy, 2000; Wong, 2004; Mont, 2004; Aurich, 2006; Williams, 2006; Azerenko, 2007). For example, a PSS without the sustainability element has been termed as a Technical PSS (Wong, 2004; Aurich, 2006), a PSS that focuses on the aspects of modular product design and product take-back as a closed-loop PSS (Mont, 2004; Williams, 2006), and a PSS that focuses on managing the industrial data as an Industrial PSS (Roy & Shehab, 2006; Azerenko, 2007). In addition, Industrial PSS is also referred to as IPS² by the CIRP community (CIRP, 2007).

3.3.2 Classification of PSS

As shown in Table 2, many classifications of PSS exist in the literature (Goedkoop et al., 1999; Mont; 2000; Wong, 2004; Tukker, 2004a; Neely, 2008; Baines et al., 2008). Goedkoop et al. classify PSS into four categories by using the relationship between products and services at the different phases of the product life span which was known as the Product-Service (PS) cross; Tukker classifies PSS into 8 different types (Tukker, 2004) and Neely defines PSS into 5 different options (Neely, 2008).

The most commonly used PSS classification has its root derived from the Eco-Service concept (Brezet et al., 2001), which classified PSS into product-oriented, use-oriented and result-oriented (Brezet et al., 2001; Zaring, 2001; Tukker & Tischner, 2006). This classification has been adopted by many PSS researchers (Manzini, 2002; UNEP, 2002a; Zhao, 2005; Baines et al., 2008).

Table 2: List of PSS Classifications

Author	Classification of PSS
Goedkoop et al., 1999	1. Ps – Service is connected to Product 2. Sp – Service provider add product 3, PS - products and services are developed in combination to provide their function fulfilment 4. STCH - innovation takes place by change of system, substituting a PS system by an improved system
Mont , 2000	1. Product System 2. Product Service Mix 3. Product Substituting Services
Tischner, 2002	1. Product Oriented PSS 2. Use Oriented PSS 3. Results Oriented PSS
Tukker, 2004a	1. Product Related Services 2. Product Related Consultancy 3. Product Lease 4. Product Renting and Sharing 5. Product Pooling 6. Pay Per Unit Use 7. Activity Management 8. Functional Result
Neely, 2008	1. Integration Oriented PSS 2. Product Oriented PSS 3. Service Oriented PSS 4. Use Oriented PSS 5. Result Oriented PSS
Baines et al., 2008	1. Product Oriented PSS 2. Use Oriented PSS 3. Result Oriented PSS

- ***Product Orientated PSS*** - Product Oriented PSS focuses on selling the product which includes additional add on services as part of the end offering to support the operational quality of the product. Ownership of the Product Oriented PSS can be retained by the manufacturer but is

normally transferred to the users. This type of PSS is commonly adopted by manufacturers who have a widely installed base to ensure on their products sold are operating in good condition. Examples of Product Oriented PSS are maintenance, repair, reuse, recycling, training, consultancy, installation, upgrading and disposable service etc.

- ***Use Orientated PSS*** - Use Oriented PSS focuses in selling the availability or use of a product through activities like leasing or sharing. Usually, the ownership of the product in a Use Oriented PSS does not belong to the customer. The use of the product is operated through the sharing activities and ownership of the product is normally still retained by the manufacturer. Examples of Use Oriented PSS are, pooling, leasing, renting and inventory buffering support etc.

- ***Result Orientated PSS*** - Result Oriented PSS focuses on selling the functionality or end results instead of a product. Its business model is based on selling a result preposition that is guaranteed by the manufacturers with the provision of Informative product that is specially designed to deliver the promised result and to facilitate maintenance and optimisation of the use phase efficiency. Typical examples of Result Oriented PSS are "Selling the copying" by Canon and Xerox, "Selling the power-of-the-hour" by Rolls Royce's engine service, "Selling the driving" by car sharing service provider and "Selling the washing" by community laundrette centre.

The graphical illustration of the classification of PSS is given in Figure 11. A list of PSS examples that are extracted from the literature is also given in

Table 3 (Goedkoop et al., 1999; MEPSS, 2004; Mont, 2004; Wong, 2004; Baines et al., 2007).

This section discussed the types and classifications of PSS. In the following section, the tools and methodologies of PSS will be discussed.

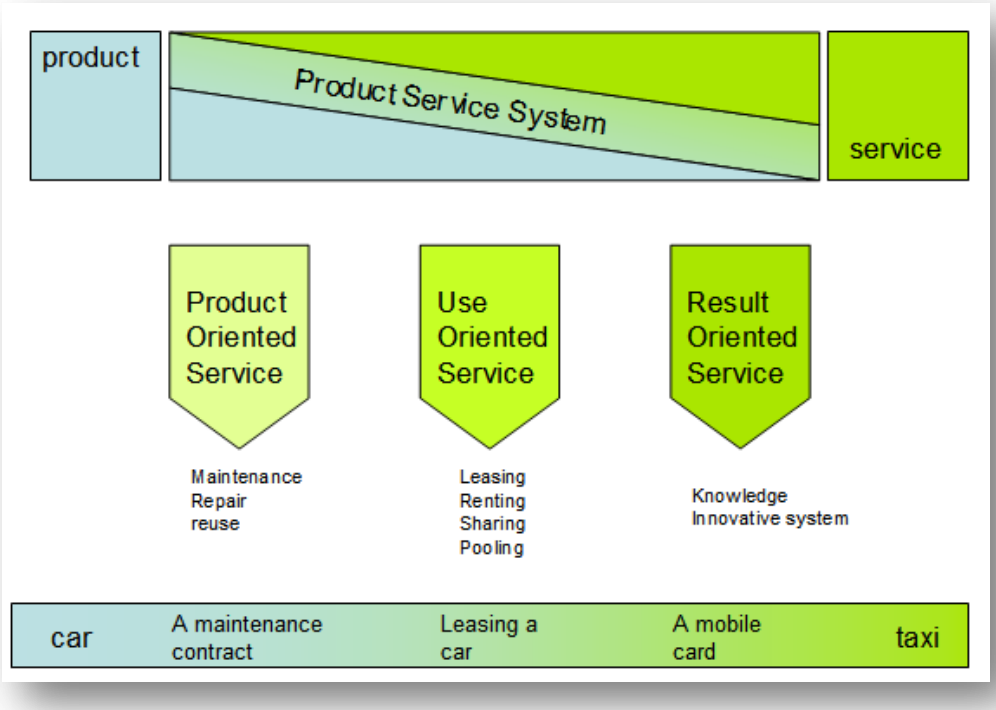


Figure 11: Classification of PSS

(Modified from Tukker & Tischner, 2006)

Table 3: List of PSS Examples

Type of PSS	Company	PSS Strategy
Chemical Management Service	General Motors Corporation, Chemical Service Department	Chemical product management services, delivery, inventory and disposal etc.
Document Service	Xerox, Ricoh, Oce, Hewlett Packard	
Car Renting Service	Car-a-car , GreenWheels, Mobility, StattAuto, Honda Motor Co., CITYgogo, Huur-op- Maat	Car renting
Energy Service	Black Country ESCo	Selling energy and energy efficient appliances as energy service package
Furnishing Service	Interface, Inc., MilliCare,Monsanto, Milliken Carpet, DuPont's flooring systems, BASF's 6ix Again, and Collins and Aikman's infinity loop.	Evergreen leasing program, leased modular carpet and services to maintain the appearance of carpet
Painting Service	ABB Flexible Automation	Instead of the painting box product, it sells the painting functions to Volvo Car Corporation
Washing Service	Electrolux, Launder Bar & Café, Wash n Tumble, Chalet Coin Laundry, Tvättman, Sophus Berendsen	Selling washing function instead of the washing machine; Launderettes and professional washing centres
Engine Hour Leasing Service	Rolls Royce, Volvo Aero, GE Capital	Engine producers sell flying hours, not just engines
"Pay-per treatment"	Gambro	Medical equipment is offered on a pay-per-use basis to doctors

Source: Goedkoop et al., 1999; MEPSS, 2004; Mont, 2004; Wong, 2004; Baines et al., 2007

3.4. TOOLS AND MEHTODOLOGIES OF THE PSS

This section provides a brief introduction to the previous and on-going research works specific to the tools and methodologies of PSS.

In the area of designing PSS, as PSS requires the shifting of product design to product service system design, this has posed a new challenge for many designers and inspired new research in this area (Manzini, 2003; Morelli, 2003). According to Morelli, in order to generate a good service blueprint, designers must learn "to understand the users' and then to model their behaviour relating to both the material and immaterial aspects of a PSS. Bey argues that one needs to have a broader view of the product, its life cycle and the stakeholder gallery in order to be able to design a PSS properly (Bey, 2006). In addition, Manzini points out that, the design of new services in PSS should be able to link the technology to the social and cultural dimensions (Manzini, 2003) Tan and McAloone, on the other hand, attempt to use the Integrated Product Development concept in designing PSS (McAloone, 2006; Tan & McAloone, 2006).

Some researchers have stressed that regulatory support and the presence of appropriate incentive structures and environmental regulations are also critical in the design and development of PSS (Wagner, 2006; Wong, 2004; Mont, 2002).

In the aspect of implementing PSS, a few methodologies can be found in the literature too. For example, Luiten et al. introduce the sustainable PSS methodology using the Kathalys method (Luiten et al., 2001); Mont presents a step-by-step PSS methodology based on Deming cycle (Mont, 2004); Wong develops a set of web-based PSS implementation tools based on the Case-based Reasoning technique for the electronic consumer goods industry (Wong, 2004) and Abdalla presents a PSS

development strategy using TRIZ (Russian acronym for inventive problem solving) to improve or design new PSS (Abdalla, 2006).

The Product Service Systems Methodology (the MEPSS project funded by European Commission under the 5th Framework Programme), has also developed a toolkit that enables the industry to develop product-service systems. The MEPSS toolkit was made available via a handbook (MEPSS, 2004) and on the website www.mepss.nl.

In the area of measuring the performance of a PSS, Goedkoop et al propose a four axis model for auditing a PSS (Goedkoop et al., 1999) The research project "Factory of Tomorrow" funded by the Austrian Ministry of Transport has also developed a tool called "INES – improving new services", for evaluating the sustainable concept of the new product service concept in comparison to the original product concept (Engelhardt, 2002; Schwarz, 2006). Aoe also generates a set of indicators for measuring sustainable and green Products and Services (Aoe, 2003).

However, there are some arguments concerning whether LCA is an appropriate tool for measuring PSS's performance. For example, Tishner et al. stress that it is impossible to use LCA for analysing services (Tishner et al, 2002), Bey and McAloone, however, argue that LCA is still capable of being used as a measuring tool for comparing different PSS solutions (Bey & McAloone, 2006).

This section has discussed the tools and methodologies relating to PSS. A more detailed description of the tools and methodology of PSS can be found in Section 6.2. In the next section, the role of PSS as a competitive strategy will be examined.

3.5. PSS AS A COMPETITIVE MANUFACTURING STRATEGY

When adopting a competitive strategy for manufacturer, the focus of PSS has been shifted from sustainability, to delivering value in use, PSS is more often regarded as a competitive strategy than a tool to reduce environmental impact (Heiskanen, 2000; Azarendo, 2007). The emphasis of the concept of PSS in manufacturing focuses in delivering functionality to fulfil customers' needs. Its role is to create economic opportunities by offering product service mix offerings to increase competitiveness through market Differentiation.

This section reviews the literature relating to the adoption of PSS as a competitive strategy in manufacturing. First, the role of PSS in Servitization is reviewed; this is followed by the discussion of the incentives of a manufacturer in adopting PSS as a competitive strategy.

3.5.1 Servitization - a New Paradigm for Manufacturers

In the context of adopting PSS as a servitized manufacturing strategy, Servitization is being seen as "the innovation of an organisations capabilities and processes to better create mutual value through a shift from selling product to selling PSS" (Baines & Lightfoot, 2007).

As discussed in Section 3.2.1, the concept of Servitization was first proposed by Vandermerwe and Rada (Vandermerwe & Rada, 1988). Vandermerwe and Rada suggest using Servitization as a competitive tool to set up barriers to competitors, creating dependency, differentiating the market offering and diffusing new innovations. In recent years, many researchers see Servitization as the movement along the product-service continuum, with manufacturers moving from providing "products with services as an add-on", to providing "services with tangible goods as an add-on" (Baines et al., 2007; Cook, et al., 2006; Gebauer, et al, 2005).

Although the concept might not be new (Schmenner, 2008), Servitization provides a possibility to shift traditional product focused manufacturing to a new servitized manufacturing paradigm with the support of advanced ICT and manufacturing and maintenance infrastructure. As pointed out by Ren and Gregory, it is a change process for manufacturing companies to embrace and develop more and better services, with "the aim to satisfy customer's needs, achieve competitive advantages and enhance firm performance" (Ren & Gregory, 2007).

3.5.2 PSS as a Competitive Strategy for Manufacturers

Many researchers believe that PSS has the potential to increase the competitiveness of a manufacturer (Wise & Baumgartner, 1999; Kosonen, 2004; Liversey, 2003). This notion draws from the fact that by offering more downstream functional services, manufacturers have created for themselves an opportunity to look beyond their current core business (Wise & Baumgartner, 1999).

Repeated Usage of Products

In addition, by repeatedly providing the same service to different customers or even the same customer base, a manufacturer might be able to achieve a greater scale of economy and maximize their profit (Morey, 2003). Some of the other benefits of adopting PSS include the possibility of repeat usage of a product in the form of renting, leasing and pooling thus allowing the products to be used more intensively (Scholl, 2006).

Better Product and Process Design

Adopting PSS also encourages a manufacturer to start at the beginning of the product service systems design and development stages to look into product take back which is increasingly becoming part of the manufacturer's responsibility (Tan & McAloone, 2006a, 2006b; Tischner & Verkuikl, 2006; Tukker, 2006). In doing so, it will also encourage the manufacturers to specifically develop new product features to monitor the usage of the products and to enhance the product reliability in order to prolong the product life span (Sundin et al., 2005). All these new efforts and strategies could therefore result in better productivity in the long run for manufacturers as better products are designed and new manufacturing process are developed.

Reduce Material throughputs

In the economics aspect, as in a transaction of the sales of a PSS, the customer pays the manufacturers per unit output of service rather than input material of product (Morey, 2003). This type of payment structure will encourage manufacturers to reduce costs associated with service and to lower the material throughputs of the physical products. This will in turn help to cure obese production and eventually encourage the manufacturers to generate more profit from the functional sales rather than increasing the sales of the volume of physical product as in the current way of doing business (Wimmer & Kang, 2006). In short, manufacturing is seen as the provision of a service throughout a product's life cycle in PSS (Sundbo, 1994; Araujo & Spring, 2006).

Since most of the manufacturers have the expertise and know-how of their products and customer's needs, they are in a better position to offer more downstream services, i.e. training, consultation, spare parts supply and maintenance to their customers (Wise & Baumgartner, 1999).

According to Helskanen, service orientation business can be interpreted "as an effort to reunite commerce and manufacturing, which have grown separate in the course of the spread of mass-production" (Helskanen, 2000).

Liversey (2003) believes that services can generate higher profit margin than traditional production especially in the case when production becomes commoditized. Moving towards Servitization provides the manufacturers with an opportunity to capitalize on their expertise, experience, knowledge and know-how to generate more value add from the servitized process (Baines et al., 2007).

New Value Generation

In general, effective exploitation of the synergies between products and services will enable a manufacturer to create the following new values (Helskanen, 2000; Livesey, 2003; William, 2005):

- Providing more added values to the entire product life cycle
- Delivering functionality of a product that is fulfilling customers' needs
- Capturing profits at the end of the product value chain on top of the traditional product sales
- Creating competitive Differentiation especially when manufacturing best practices became standard practice or being copied
- Providing higher profit margin than traditional production especially in the case when production becomes commoditized and smaller profit reduced

In summary, PSS offers companies more opportunities to exploit the value that they have created at the production stage. For manufacturers this represents a significant opportunity to access a greater portion of the value chain to create new competitive strategy to sustain their business growth and profitability (White et al., 1999; Oliva & Kallenberg, 2003).

Generation of Competitive Strategic Positioning

Due to the potential added value incentives generated by moving downstream, a PSS strategy may be able to improve a company's strategic positioning (Cook et al., 2006). The manufacturer are able to improve the strategic positioning through Differentiation by the creation of a new market niche, building up of new capabilities and establishment of new customer management skills and relations (Manzini, 2003). Manufacturer can create the perception and image that it offers superior customer service to fulfil customer's needs and thus differentiate itself from competitors.

Apart from the points discussed above, some of the other competitive advantages of a PSS strategy can be summarized as follows:

- **Develop new market** (White et al., 1999) -- the differentiated offer of a new product service mix offering generated by a PSS business model, delivers high value and quality service to customers, will in turn capture and develop new market for the company

- **Increase organisational flexibility** (Oliva & Kallenberg, 2003) – the inclusive of services as part of the product sales requires more responsive and flexible organisation structure and culture in order to cater for a more rapid changing consumer demands and market

- **Create long term customer relationships** (Mont, 2002) – the delivery and sales of functionality require the company to foster strong company customer relationships as the sale transaction no longer ends when the product is handed over to the customer. Taking care and make sure that the functionality can be delivered by the product sold throughout the entire contracted period of the sale becomes the manufacturers' legal responsibility

- **Improve corporate identity** (Mont, 2002) - the creation of a more environmental friendly and socially oriented business strategy enables the company to establish a better corporate identity through a better execution of its corporate social responsibility.

- **Improve business strategic positioning** (Cook et al., 2006) – the existing and future environmental legislative requirements and restrictions in the West have become more stringent in recent years. Companies are under pressure and stress to overhaul production, product and services to meet the requirements of Extended Producer Responsibility (EPR), Restriction of Hazardous Substances Directive (ROHS), resource taxes, environmental performance labelling and individual national environmental standards set by different countries.

- **Improve Economic efficiency** (Morey, 2003) -- economic efficiency is the allocation of resources that maximizes net benefits. PSS can achieve economic efficiency through increasing the frequency of utilization of the

products by selling it many times in comparison to a pure product offering where products can only be sold once.

These sections discussed the role of PSS as a competitive strategy for manufacturing. In the next section, the current research issues of PSS will be reviewed.

3.6. REVIEW OF THE CURRENT RESEARCH ISSUES

3.6.1 Traditional Manufacturing Operation Tools Mainly Developed for Product Manufacturing

As pointed out by Wilkinson et al., traditional operations management tools, techniques and frameworks, were developed for traditional product manufacturing (Wilkinson et al., 2008). As the manufacturing companies moves towards Servitization, the models and methodologies used by the traditional product oriented operations management community needed to be modified and enhanced too. For example, as the firm moves to provide more services, there is "an inevitable by-product of an increasing division of labor and disaggregation of corporate hierarchies", and thus manufacturing companies need to re-assess what needs to be produced in house and what needs to be outsourced (Araujo & Spring, 2006).

To date, despite the fact that many manufacturers are moving towards Servitization, there is very little work carried out in the area of integrating services into the corporate competitive analysis and strategy formulation process (Baines and Lightfoot, 2007). Hence, there is a need to develop tools and methodologies to aid manufacturing firms to effectively integrate manufacturing and PSS. Although some works have been done, for example, Lee has proposed a framework for integrating manufacturing and PSS (Lee, 2006); the focus was more on the

development of a framework for web-oriented software architecture instead of methodology for management operation and integration.

3.6.2 Current Research Biased Towards Design for Sustainability

Currently there are a number of PSS methodologies developed for designing, implementing and assessing the performance of PSS, however, the focus of these approaches are mainly biased towards attaining sustainability and reducing environmental impact (Goedekoop et al., 1999, 2000; Mont, 2001; Lamvik, 2001; van Halen et al., 2004; Abdalla, 2006; Kobayashi and Kumazawa, 2006;). For example, the Innovation Management methods and tools using TRIZ for sustainable PSS developed by Abdalla (2006), the 4 axis model developed by Goedekoop et al. (1999) and the MEPSS methodology (MEPSS, 2004) are all developed for the purpose of evaluating the sustainability and life cycle performance of a new PSS. Although, some of the authors such as Maxwell (2003) have attempted to develop a procedural method to design PSS considering dimensions like economy, ecology as well as social aspects, the primary intention is still coming from the sustainable point of view.

3.5.3 Lack of Practical Methodology to Evaluate the Competitiveness of a New PSS Strategy

As pointed out by Oliva and Kallenberg, expansion into Servitization generates new uncertainties, game rules and challenges for the manufacturers. It requires significant organisational changes in values, design process, language, and organisation structure (Oliva and Kallenberg, 2003). Manufacturers need to develop a new competence profile and core competency base and undergo organisational changes, both structurally and infrastructurally (Baines & Lightfoot, 2007). To a certain extent, competences, resources and capabilities which may

be new to the manufacturer result in collaborations with other partners (Pawer et al., 2004), or formation of a decentralized new service unit with different metrics and performance measures to support the new service activities(Gebauer and Friedli, 2005).

Currently, although a few researchers have been looking into developing frameworks and models to identify issues and challenges faced by manufacturers moving into Servitization, there are no tools or methodologies available to support the transition to servitized manufacturing. In particularly, when a manufacturer decides to go for Servitization, there is also a lack of effective tool or methodologies developed to help evaluate whether such a decision is a competitive move (Baines et al, 2009).

3.7. CHAPTER SUMMARY

This chapter provided an overview of the literature review of the concept of PSS. It discussed the definition of PSS and the terms relating to the definition of PSS such as product, services and "Value in Use". The definition of PSS and Servitization, its history, classification, tools and methodologies and the role of PSS as a competitive strategy for manufacturers have been discussed. It has reviewed the current research issues relating to the development of tools and methodologies in supporting manufacturers in adopting a new PSS strategy. The literature review performed in this chapter has helped in identifying the research gaps in the development of the new PSSE methodology, which is the focused research area of this thesis. The next chapter will deal with the design and development of a research programme aimed at developing the new PSSE methodology.

CHAPTER 4: RESEARCH AIM AND PROGRAMME

Chapter 2 highlighted the industrial problems faced by the Singapore manufacturing industry and Chapter 3 presented the results of the literature review of PSS. The results of the reviews in these two chapters have led to the establishment of the research area. This chapter describes the research aim and programme of this research. It first discusses the research problem in Section 4.1 and then research aim in Section 4.2. The chosen research method is described in Section 4.3 and the structure of the research programme in Section 4.4. The chapter Summary is provided in Section 4.5 and an overview of this Chapter is presented in Figure 12.

4.1. THE RESEARCH PROBLEM

Singapore has been consistently highly ranked high as one of the world's most competitive nations in terms of economic growth and overall competitiveness (Section 2.1), and manufacturing has been playing an important role in sustaining the growth of the Singapore economy (Section 2.2). Like many of the developed countries in the West, Singapore is gradually shifting from low value labor intensive manufacturing to high value manufacturing to sustain its competitiveness which involves the exploration and exploitation of values generated from the downstream value chain activities (Section 2.2.1). Service has been long seen as an important sector to support the growth of high value manufacturing (Section 2.2.2). Thus, one of the key

recommendations by ESC is to increase manufacturing related services by captivating the synergy and convergence of manufacturing and services (Section 2.2.2). However, being a small state country, Singapore needs to take care of its environment while sustaining the growth of the manufacturing industry (Section 2.2.3). In summary, to sustain long term competitiveness, Singapore needs a solution that can link manufacturing and services into a competitive strategy (Section 2.3).

The literature review conducted in Chapter 3 has reviewed that PSS is an ideal competitive strategy for the manufacturing industry to tackle the above highlighted problem (Section 3.2). A good competitive PSS strategy provides manufacturers with an opportunity to create Differentiation by offering competitive products and services offerings that are able to deliver value in use to fulfil the needs of the customers (Section 3.3). However, as highlighted in Section 3.4, currently there is a lack of manufacturing methodologies to assist manufacturers in assessing the competitiveness of the adoption of a new PSS strategy (Section 3.4.3), as most of the existing methodologies are biased towards the assessment of the sustainability and focus in reducing the environmental impact of new PSS design (Section 3.4.2).

This research, therefore, sets out to explore the concept of PSS as a viable strategy to improve the competitiveness of the product manufacturers by developing a methodology to assess whether the adoption of a PSS is a good competitive strategy. The methodology developed in this research must be a good and practical methodology that is useful, feasible and usable.

4.2. DEVELOPMENT OF RESEARCH AIM AND OBJECTIVES

The research problems discussed above has thus led to the generation of the aim of this research:

> *"To design and evaluate a methodology that will enable the manufacturing companies in Singapore to assess whether the adoption of PSS is a good competitive strategy"*

In order to realise the research aim, the following objectives have been defined:

1. Identification of the requirements set of the methodology
2. Evaluation and selection of existing methodologies against the established requirements set
3. Formation of a pilot methodology through synthesis of literature and industrial data
4. Evaluation and refinement of the pilot methodology through application in practice
5. Testing the refined methodology through more industrial applications and generation of the final PSSE methodology

The main outcome of the research is a PSSE methodology which is developed using the set requirements identified and its practicality and usefulness will be tested and validated by using industrial applications from the Singapore manufacturing industry. The structure of the research programme developed to realise the aim and objectives of this research is illustrated in Figure 12 and is discussed in following Section.

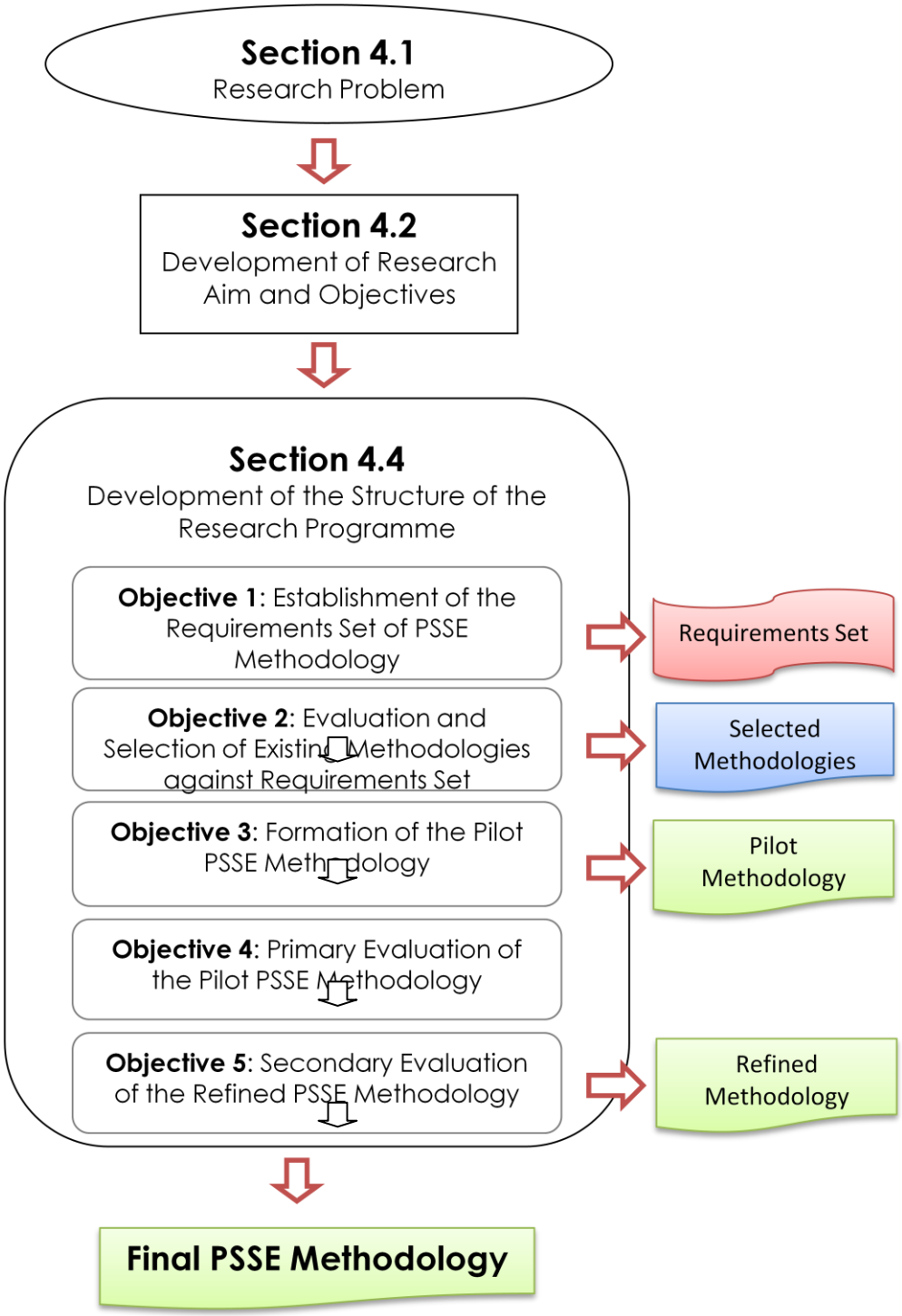


Figure 12: Overview of the Development Process of the Research Programme

4.3. IDENTIFICATION OF RESEARCH METHOD

This Section provides a brief discussion of the research methods. Research methods can be classified by their purposes, the processes they used to conduct the research and the outcome it expected to produce. The purpose of the research method is generally classified into four categories namely, Explanatory, Exploratory, Descriptive and Predictive (TVU, 2010). The process of the research method can either be qualitative or quantitative, and the outcomes of the research can be classified as Basic, Applied or Action (TVU, 2010).

4.3.1 Identification of the Research Method

This Section discusses the purpose of the research method, namely, Explanatory, Exploratory, Analytical and Predictive:

- *Exploratory Research* -- Exploratory research is ideal in finding out what is happening particularly in a little-understood situation or pattern (TVU, 2010). It can also be used to seek new insights to new and emerging subjects by asking questions. It is a typical research method used commonly for solving problems that have not been clearly defined and it is generally qualitative in its approach.
- *Descriptive Research* -- As for the method of descriptive research, it is normally used to portray an accurate profile of phenomena, an event, a person, or condition in a descriptive manner (TVU, 2010). Descriptive research usually requires quite a substantial amount of knowledge about the topic or situation, and data must often be gathered to provide a clear picture and to assist in the

research. In the descriptive research method, the process used to collect data is usually qualitative.

- *Explanatory Research* -- Explanatory research is a continuation of the Descriptive Research (TVU, 2010). Its purpose is to seek an explanation for the casual relationships of a problem or situation. It is an ideal research method to use in explaining patterns relating to a problem under research, and in identifying the relationship between them. The data collecting process can be both quantitative and qualitative.
- Predictive Research - Predictive research aims to forecast the likelihood of a situation or predict certain phenomena by applying the hypothesis generated in another situation (TVU, 2010).

As the first objective of the research is to establish the requirements set of the PSSE methodology from both the industry and literature, the nature of its intention makes it an ideal case to be of an exploratory research. Exploratory research involves the review of existing available literature and data. It normally makes use of qualitative approaches such as informal discussions with the companies or more formal data collection approaches such as conducting in-depth structured interviews. The process of collecting data is qualitative.

However, the last two objectives of the research require the developed PSSE methodology to be evaluated using industrial applications to validate its usability. The nature of the research has been identified as explanatory as data must be gathered to provide a clear picture of the result of the evaluation, and to explain the patterns and to identify the relationship between the different industrial applications. The process of collecting data can be both qualitative and quantitative.

This Section has discussed the different types of research methods and identified the methods identified to be used for this research: exploratory and explanatory. The next Section will discuss the data collection research methods.

4.3.2 Identification of Data Collection Research Method

A few types of methods can be used to collect research data. These are: case study, experiment, history, archival analysis and survey (Robson, 2004). In deciding the most appropriate data collection method for this research, the following three main conditions have been used for consideration as suggested by Yin (2003):

- First, the type of research questions are defined, i.e. in the case of this research, these are the How and What questions.
- Second, the extent to which the researcher or investigator has control over the actual event itself, and
- Finally, the degree of focus on contemporary events

Table 4 provides a brief comparison of these few methods. It shows that research methods like Experiment, Case Study and History are most suitable for conducting research dealing with research questions of the nature of "Why" and "How". Archival Analysis and History are most preferred when dealing with circumstances when there is no access to a situation. A case Study is ideal when dealing with contemporary events, where the relevant behaviours cannot be manipulated. A survey is suitable for answering the "Who", "What" and "How" types of research questions.

Table 4: Characteristics of Different Data Collection Research Methods

Adopted from Yin (2003)

Data Collection Research Method	Type of Research Questions	Suitability of Contemporary Events	Requirements of Behavioural Control
Experiment	Why, How?	Yes	Yes
Case Study	Why, How?	Yes	No
Archival Analysis	Who, What, Where, How Much, How Many?	Yes/No	No
Survey	Who, What, Where, How Much, How Many?	Yes	No
History	Why, How?	No	No

In the context of this research, the earlier stage focuses on the understanding and establishment of the requirements set for the PSSE methodology from the industry and literature. It involves answering the "What is the requirements set of the PSSE methodology?" and "How to collect the data" research questions which make it ideal to use survey at this stage of the research.

The last two objectives of the research require the evaluation of the new PSSE methodology using actual industrial applications. In the execution of the research activities, the researcher has little control over the development of the actual event itself. According to Yin (2003) and Chandraprakaikul (2008), in a situation where the information pertaining to a subject being studied is lacking and requires further exploration of the contemporary events from the company practices, a case study is the most appropriate method. Many researchers have adopted the case study research method to deliver research objectives in similar

context (Baines, 1995; Adesola, 2002; Viseras, 2004; Lim, 2007; Chandraprakaikul, 2008).

Although both single and multiple case studies can be used (Eisenhardt, 1989), in order to identify a common pattern across different cases, multiple case studies have been chosen. Hence multiple case studies have been identified as the research method to be used for the last two phases of research as it involves the empirical investigation of "a particular contemporary phenomenon within its real life context using multiple sources of evidence" (Robson, 2004).

This Section has provided a brief description of the various data collection research methods. Case Study has been identified for this research and will be used in delivering objectives 3, 4 and 5. The structure of the research programme, formed by using the identified research methods, is described in the following Section.

4.4. STRUCTURE OF THE RESEARCH PROGRAMME

The research programme was structured in a way that the research aim can be addressed in a systematic manner. It puts together a series of activities in a sequence of phases using the most appropriate research methods to achieve the research objectives. The five phased research programme developed is illustrated in Figure 13. Basically, as briefly described in Chapter 1, the structure of the research programme is divided into two Sections, namely, Design of the PSSE Methodology and Evaluation of the PSSE methodology.

4.4.1 Design of the PSSE Methodology

The "*Design of Methodology*" Section of the research programme consists of 3 phases designed to address the first three research objectives;

- Phase 1 (Section 4.3.3): to identify the requirements set for the PSSE methodology, which involves soliciting feedback from the industry as well as gathering established theories and knowledge from the literature
- Phase 2 (Section 4.3.4): to select potential methodologies as a conceptual base, which includes identifying existing methodologies from the literature in the area of PSS and manufacturing strategy against the requirements set and selecting a potential methodology
- Phase 3 (Section 4.3.4): to formulate the structure of the pilot methodology, which involves identifying appropriate components from the selected existing methodologies and develop new tools or stages in order to be able to deliver the expected outcomes of the PSSE methodology

One of the main research activities in this Section is to understand the requirements of the set characteristics that contribute a good and practical methodology from the literature. It also involves finding out the most preferred delivery mechanism for the methodology from the Singapore manufacturing industry. The research methods used in the first Section of the research programme include conducting semi-structured interviews with Singapore based companies. The results of this Section are documented in Chapters 5-7.

4.4.2 Validation of the PSSE Methodology

The "*Validation of Methodology*" Section of the research programme consists of 2 phases designed to address the last two research objectives;

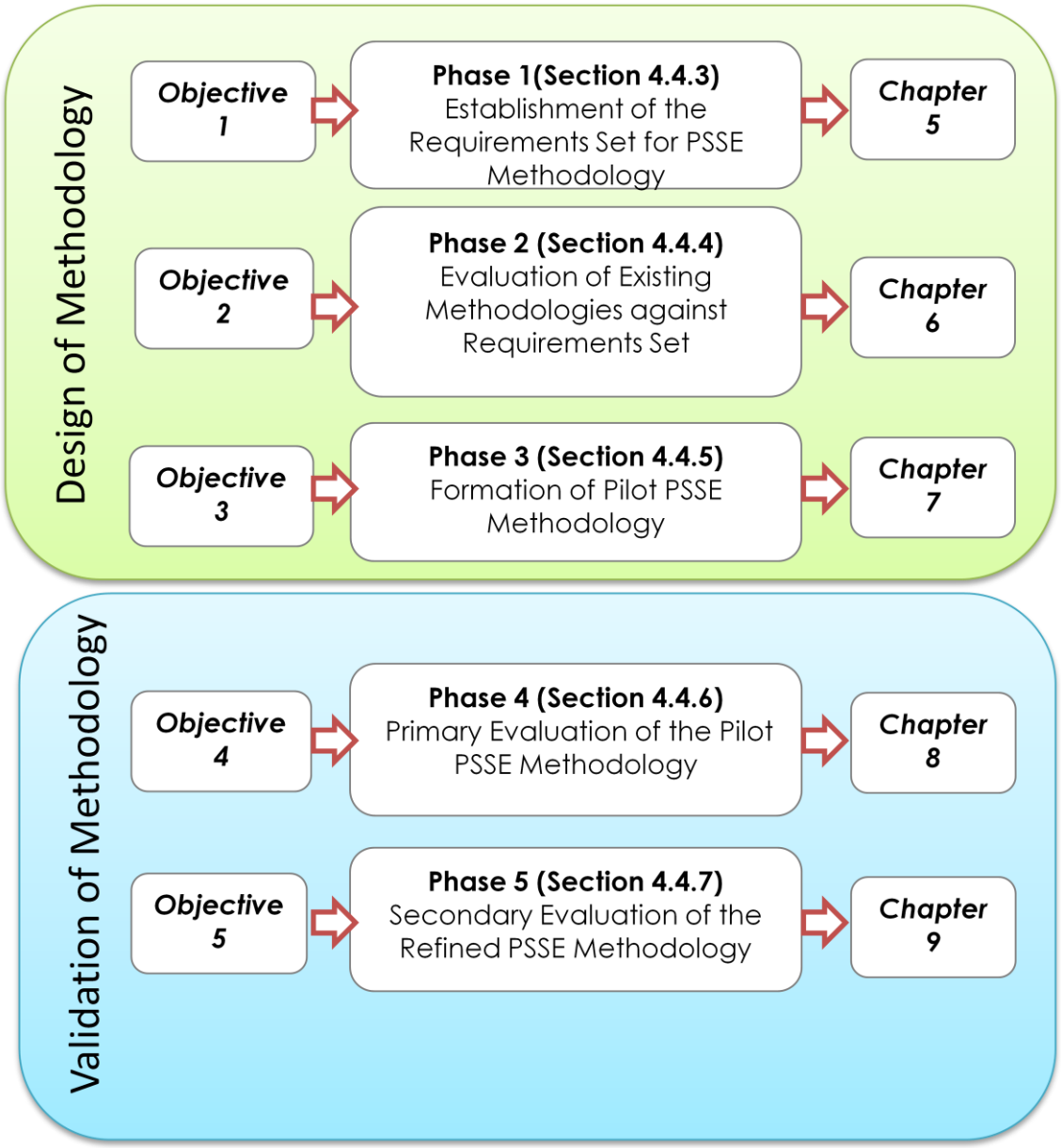
- Phase 4 (Section 4.4.6): to perform the primary evaluation of the pilot PSSE methodology, which involves validating the usefulness, feasibility and usability of the methodology and to identify areas for improvement
- Phase 5 (Section 4.4.7): to conduct the secondary evaluation of the refined PSSE methodology, which includes further validating the usefulness, feasibility and usability of the refined methodology using more industrial applications

This Section of the research programme concentrates on testing and validating the PSSE methodology using actual company applications. The pilot PSSE methodology is first tested to identify areas for improvements with the researcher acting as a facilitator and/or participant. Feedback gathered during the first evaluation is used to refine the methodology. The refined methodology is then validated using more industrial applications with independent facilitators to ascertain its usefulness, usability and feasibility. The results of this Section are documented in Chapters 8 and 9.

4.4.3 Phase 1: Establishment of the Requirements Set for the PSSE Methodology

The first phase of the research programme aims to deliver the first objective of the research which is the establishment of the requirements set for the PSSE methodology. It involves two main activities: first, to gain knowledge from the literature concerning the requirements needed to formulate the new PSSE methodology, and second, to gain feedback from the practitioners and companies within Singapore industry concerning the most preferred delivery process of the new PSSE methodology.

Figure 13: Overview of the Structure of the Research Programme



This phase also involves understanding "Why" manufacturing firms are moving towards Servitization and "How" they strategise their product service strategy. In the aspect of gathering feedback from industry, especially in understanding their practices, survey is the appropriate

research method. The best way of conducting a survey is to first define the data collection protocol. This involves designing Interview Questionnaire, determining the number of participating companies, defining the criteria for the selection of the companies, as well as selecting the method for executing and analysing the data collected (Baines, 1995; Lamvit, 2001; Adesola, 2002; Yin, 2003; Mont, 2004; Lim, 2007; Chandraprakaikul, 2008).

The main outcome of phase 1 is the requirements set for the new PSSE methodology. These are generated from the key findings from the industrial case studies together with the knowledge gained from the literature conducting in this phase. The requirements set will be used to formulate the PSSE methodology in phase 3 of this research programme. A detailed description of the execution of phase 1 of the research programme will be presented in Chapter 5.

4.4.4 Phase 2: Evaluation and Selection of Existing Methodologies against the Requirements Set

Platts (1993), Baines (1995), Adesola (2002), Viseras (2004), Lim (2007) and Chandraprakaikul (2008) stress that the methodology formulation process must be established upon the existing knowledge in order to provide a solid conceptual base for the new methodology. Hence, the objective of phase 2 of the research programme is to deliver the second objective of the research, which is to evaluate existing methodologies against the set requirements generated in phase 1 and to select the most appropriate methodologies to act as a conceptual base for the development of the new PSSE methodology.

The research method preferred in this phase is to study literature of the existing methodologies relating to PSS and manufacturing strategy theory. The main activities include selecting the most suitable existing

methodologies from the literature, comparing the content of the selected methodologies against the requirements set, and finally selecting the top three most suitable methodologies to act as the conceptual base for the development of the new PSSE methodology.

The main outcome of phase 2 is a list of selected potential methodologies that can be used to form the conceptual base of the new PSSE methodology. A detailed description of phase 2 of the research programme will be presented in Chapter 6.

4.4.5 Phase 3: Formation of the Pilot PSSE Methodology

Phase 3 of the research programme is designed to deliver the third objective of this research. It involves two main activities; first, the development of a theoretical framework of a PSS competitive model, and second, the development of the structure and content of the new PSSE methodology. The development of the PSS competitive model is critical in this phase as it provides a description of the competitive elements of a PSS strategy and provides guidelines to the subsequent development of the pilot PSSE methodology based on the conceptual base provided by the existing methodology.

The research method adopted in this phase is to first determine the competitive elements of a PSS strategy based on the result of the literature review conducted in Chapter 3. The structure and content of the pilot PSSE methodology is then defined based on the PSS competitive model and the set characteristics that can be used to form a good PSSE methodology (i.e. process, tools, techniques, and worksheets) extracted from the selected methodologies.

The main outcome of phase 3 of the research programme is a set of clearly defined procedural stages that have formed the main structure

of the pilot PSSE methodology. A detailed description of the execution of this phase is presented in Chapter 7.

4.4.6 Phase 4: Primary Evaluation of the Pilot PSSE Methodology

Phase 4 of the research programme is to deliver the forth objective of this research, which is to assess and evaluate the effectiveness of the pilot PSSE methodology through rigorous testing and refinement of the methodology by using industrial case studies. The purpose of this phase is mainly to test the flow of the evaluation process of the pilot PSSE methodology and to solicit feedback to refine the methodology before implementing it in a wider application.

As discussed in Section 4.3, the outcome of research can be Basic, Applied or Action. The research method adopted in this phase is the Action research method as the researcher not only needs to participate in the testing process but also seeks to influence the way in which the testing process is being conducted (Tan and Platts, 2005). In addition, as the methodology is still in its infancy stage, the researcher needs to act as a facilitator to catalyze the testing process in order to ensure a smooth progress and at the same time, to observe and identify weaknesses of the methodology. Platts (2003) has suggested in this phase of research, it should start with a small number of companies. Thus, two case studies with participant intervention have been chosen for this phase.

The outcomes of action research are usually a set of solutions to the intended problems, intended and unintended learning and contribution to the knowledge. In this case, the research carried out in phase 4 has yielded a set of results for use in the further refinement of the pilot PSSE methodology, as well as the new structure of the refined pilot PSSE methodology.

Detailed descriptions of the execution of phase 4, including data collection protocol, a description of the participating companies and execution of the case testing are provided in Chapter 8.

4.4.7 Phase 5: Secondary Evaluation of the Refined PSSE Methodology and Generation of Final Methodology

The last phase of the research programme is to evaluate the refined pilot PSSE methodology in wider applications through testing it in more companies using facilitators who are new to the process. The purpose of this phase is mainly to ascertain the applicability, feasibility and usefulness of the refined PSSE methodology in an independent manner without the intervention of the researcher. Both trained and untrained facilitators have been involved in the testing of the refined PSSE methodology in order to provide feedback from both the professional and beginner's perspective. The researcher mainly acts as an observer and solicits feedback only through discussion with the companies in the aftermath.

The last phase of the research programme is also to generate the final methodology by performing cross case studies of the results obtained from phase 4 and this phase. The final PSSE methodology is developed by fine-tuning the refined PSSE methodology based on the feedback solicited from both the external facilitators and participants from the case studies conducted.

The research method used in this phase is similar to Phase 4 of the research programme. The set of criteria that has been used for assessing the usability, feasibility and usefulness of the pilot methodology in Phase 4 is adopted here. However, the companies involved in this phase are different from phase 4 and are mainly selected from the companies that have participated in phase 1 of this research programme.

Chandraprakaikul (2008) argues that a total number of between 4 to 6 companies would be ideal in this phase. Thus, 4 companies will be selected to participate in the secondary evaluation of the methodology.

The outcome is a fully tested and refined final PSSE methodology in the form of a Facilitator Guide. A detailed description of the execution of this phase of the research programme is presented in Chapter 10.

4.5. CHAPTER SUMMARY

This chapter provided an overview of the research problems, aim and objectives. It defines the nature of this research and presents a five-phase research programme which has been designed to achieve the research aim and satisfy academic requirement. Phases 1 to 3 focus on research activities related to the design of the PSSE methodology and Phases 4 to 5 focuses on the evaluation and testing of the methodology. The research programme has made use of both the semi-structure interview and case study method to achieve the research aim and objectives. Detailed descriptions of the research programme are provided in Chapters 5 to 10. In the next chapter, the requirements set for the new PSSE methodology will be discussed.

CHAPTER 5: ESTABLISHING THE REQUIREMENTS SET FOR THE PSSE METHODOLOGY

Chapter 4 presented the research aim, objectives and the structure of the research programme. This chapter deals with the execution of the first phase of the research programme. The first phase of the research programme is designed to generate the requirements set for the PSSE methodology. This phase is important as it sets the foundation, defines the scope and provides guidelines for the development of the new PSSE methodology. As discussed in Section 4.4.1, this phase of research involves two main activities, first, to gain knowledge from the literature concerning the requirements of the characteristics set of a good and practical methodology and second, to solicit opinions from the companies in Singapore's manufacturing industry concerning the content and preferred delivery mechanism of the new PSSE methodology.

This chapter is structured to first present the objective and method of the phase 1 of the research programme (Section 5.1) followed by discussing the generic requirements for the formulation of a manufacturing strategic decision methodology from the literature point of view (Section 5.2). The structure of the data collection protocol designed to collect information from Singapore industry is described in Section 5.3, and the final requirements set for the new PSSE methodology are presented in Section 5.4. A chapter summary is provided in Section 5.5.

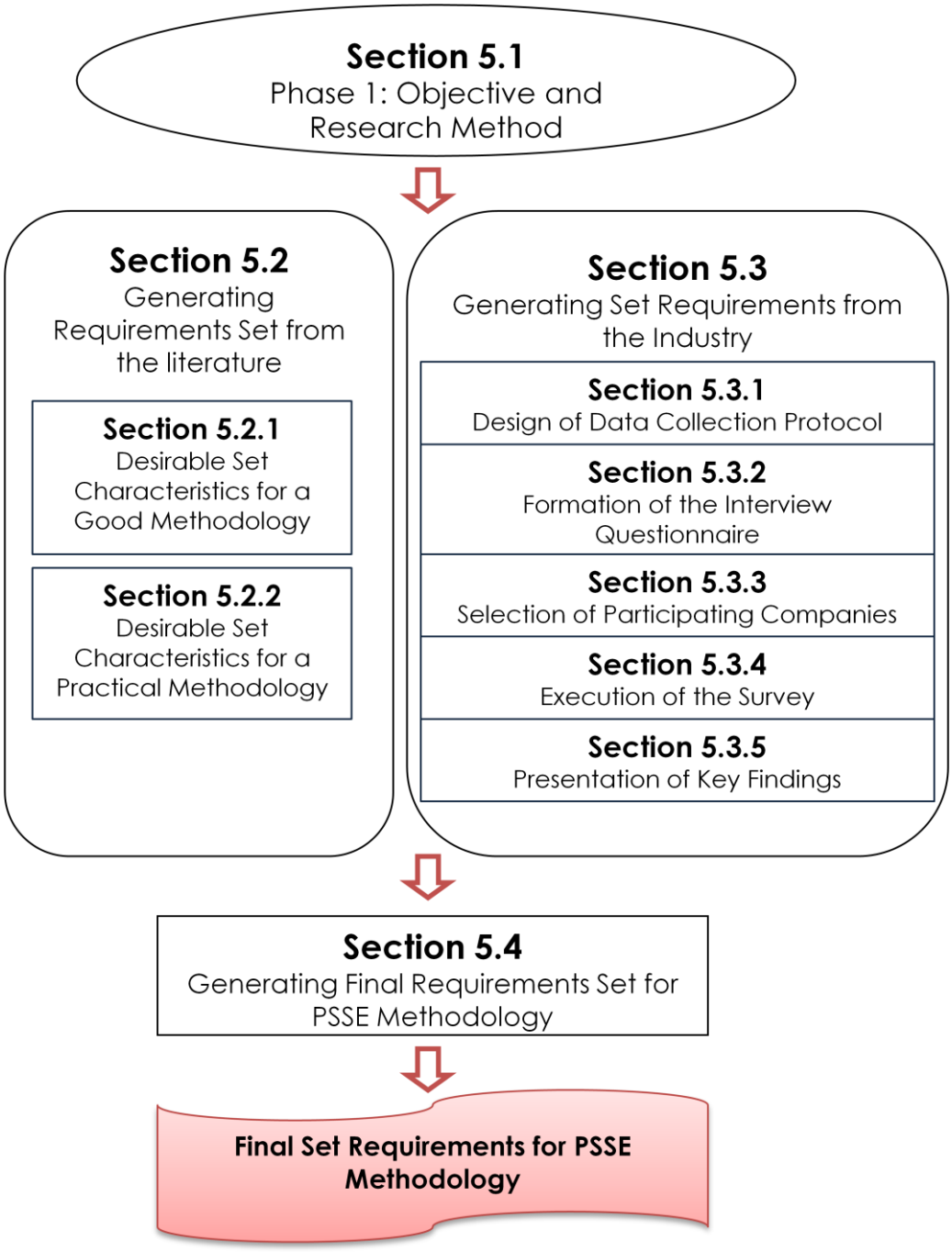


Figure 14: Overview of the Structure of Phase 1 of the Research Programme

5.1. PHASE 1: OBJECTIVE AND RESEARCH METHOD

The objective of this phase of the research is to establish the requirements set for the PSSE methodology (Section 4.4.3). Basically, these can be divided into two parts. First, the generic requirements of the basic elements that form a good and practical methodology, and second, special requirements set pertaining to the delivery mechanism and context of applying this methodology in Singapore industry.

The first part of the requirements set can be generated from knowledge gained from literature and previous work carried out in the area of manufacturing strategy since the objective of this research programme is to develop a PSS evaluation methodology for the manufacturing industry (Section 5.2.1 & 5.2.2). In the second part of the requirements set of which concerns the context and preferred delivery mechanism of the PSSE methodology, preferences and opinions can be sought from the companies in Singapore that are interested in adopting PSS as a competitive strategy (Section 5.3).

The procedure of generating the required requirements set is shown in Figure 15. Basically the Information to be sought in this stage includes the following:

- Characteristics set for a good methodology
- Characteristics set for a practical methodology
- Preferred delivery mechanism
- Preferred content of the new PSSE methodology

Section 4.4.3 has stated that survey is the most suitable research method for gathering the desired information. There are a number of data collecting methods that can be used in the collection of data for use in

case study research. These methods include observation, interviewing and questionnaires (Kumar, 2005). According to Kumar, interviewing is the most appropriate approach for gathering complex information and for studying sensitive areas in depth due to the fact that the interviewee can be pre-empted of the topics to be discussed before the interview session. Furthermore, prior to the interview, the interviewer has the opportunity to prepare questions to guide the interview in order to make the interview process more efficient and fruitful. In the case of this research, in view of the information to be collected and the nature of the research, a semi-structured interview and questionnaire methods have been adopted due to the fact that such as combination is able to allow in depth discussions of the topics. In order to set the scope and guide the flow of the semi-structured interview, a Interview Guide is developed (Table 8). The formation of the Interview Guide is described in Section 5.3.2. In summary, the purpose of the research method adopted in this stage is survey. The information collection method endorsed is semi-structured interviews with questionnaires guided by a pre-designed Interview Guide. The following Sections of this chapter are the results of applying these research methods.

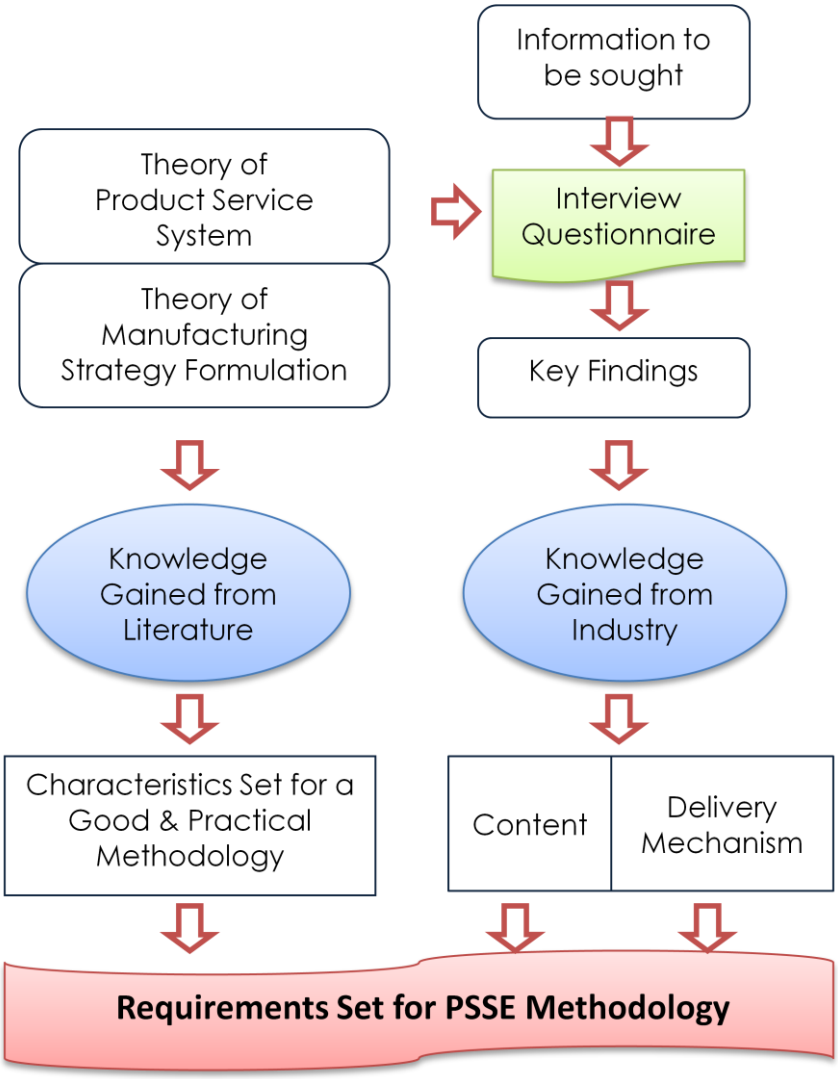


Figure 15: Generating the Requirements Set for PSSE Methodology

5.2. GENERATING REQUIREMENTS SET FROM THE LITERATURE

5.2.1 Desirable Characteristics Set for a Good Methodology

Basically knowledge from all schools of strategic theories provides good sources of useful knowledge for the development of the PSSE methodology. As the context of this research is set within manufacturing it is logical to develop the PSSE methodology based on this pool of well established manufacturing strategy concepts as it has been growing

tremendously in term of research content in the past few decades (Skinner, 1969; Hayes and Wheelwright, 1984; Hill, 1987; Marucheck et al., 1990; Platts & Gregory, 1990; Platss, 1994; Baines, 1995; Lee, 2007; Lim, 2007; Chandraprakaikul, 2008).

Platts in 1994 identifies four common sets of characteristics of a methodology that can be used for successful strategy formulation. He stress that a well designed delivery process of a methodology with the right characteristics will ensure the strategic decisions to be reached more effectively and accurately (Platts, 1994). Table 5 shows the desirable characteristics of a methodology established by Platts for the formulation of a manufacturing strategy. It shows that a good methodology should consist of well defined stages for gathering information, simple tools and techniques for analysing information, a workshop or decision making forum for encouraging groups or individual participation, and efficient methods for executing project management.

Table 5: Desirable Characteristics of Good Manufacturing Methodology

Adapted from Platts (1994)

Point of Entry	Procedure	Participation	Project Management
○ Clearly defined expectations ○ Understanding and agreement of managing a group ○ Commitment from managing and operating groups	✓ Well defined stages of: ○ Gathering information ○ Analysing information ○ Identifying improvement ○ Simple tools and techniques ✓ Written Record	✓ Individual and group achieve: ○ Enthusiasm ○ Understanding ○ Commitment ✓ Workshop style ○ Agree objectives ○ Identify problems ○ Develop improvements ○ Catalyse involvement ✓ Decision making forum	✓ Adequate resourcing identify: ○ Managing Group ○ Supporting Group ○ Operating Group ✓ Agreed Timescale

The set of desirable characteristics, as shown in Table 6, is a suitable foundation to be used as the basic requirements for the formulation of a good and practical PSSE methodology. It has been used by many researchers in the field of manufacturing strategy as reference to formulate their manufacturing strategy and have been adopted in the development of methodologies in areas like strategy modelling, supply chain strategic positioning, and business process modelling etc. (Baines, 2005; Lim, 2007; Chandraprakaikul, 2008). Following is a brief description of the key elements of the characteristics set for what can be considered as a good methodology:

Point of Entry - First, a good methodology should consist of a clearly defined expectation and intended outcome. It needs to draw full support and receive commitment from the management and operation teams, and must be able to achieve an agreement amongst the various management groups.

Procedure - Second, a good methodology should consist of well defined procedural stages to deliver the intended outcome systematically. These include guidelines to manage, operate and support the operation of the team to gather and analyse information and identify areas for improvement. It should also contain simple tools and techniques for conducting the proposed activities and provide well written documentation at the end of every stage to record the progress and results.

Participation - Third, a good methodology should provide a platform and means to allow participation of individuals and groups to achieve common understanding and develop commitment to deliver the intended outcome. Ideally this can be in the form of a workshop to allow participants to identify problems, agree on objectives, develop improvement and catalyse involvement.

Project Management - Last but not least, a good methodology should provide adequate resourcing for managing, supporting and operating the groups involved in the discussion. It should provide the means for the groups to set an agreeable time scale for the intended activities and outcomes.

Based on the set of characteristics described above, Viseras (2004) and Lim (2007) have further re-organized it into seven more specific categories as shown in Figure 15. The set characteristics proposed by Platts have been validated by both Lim (2007) and Chandraprakaikul (2008) in more than 10 case studies from both the Singapore and UK industries (Lim, 2007; Chandraprakaikul, 2008). Since methodologies developed based on this characteristics set have been tested with contemporary manufacturing case studies, it is thus logical to adopt it as the basic requirements set for the development of the new PSSE methodology.

Table 6: Requirements Set for a Good Methodology

Characteristics	Description
Scope and objectives	Clearly defined scope and objectives
Step-by-Step Structure	Well defined procedures and overall structure of the methodology
Tools and techniques	Simple and easy to use tools and techniques
Platform for Participation	Platform to allow participation of stakeholders
Project management	Efficient project management method and guideline
Template for Documentation	Written design record format of the results of each stage
Expected Deliverables	Cleary defined outcome and deliveries of each stage and overall methodology

5.2.2 Desirable Characteristics of a Practical Methodology

Having looked into the set characteristics that constituted a good methodology, the practicality aspect of a methodology is now examined. In order for a methodology to be implementable, apart from considering the essential good elements, it must be practical too. Platts (1990) has established three criteria for the assessment of the practicability of a methodology. These criteria are, *Feasibility* (How feasible is the methodology, can it be followed?), *Usability* (How usable is the methodology? Can it be easily applied and followed?), and *Usefulness* (How useful is the methodology? Can it deliver the outcome as expected?). Thus, in order to develop a practical methodology, the set of requirements as shown in Table 7 can be used as the assessment criteria, as well as to form the requirements set for a practical PSSE methodology.

Table 7: Requirements Set for a Practical Methodology

Characteristics	Description
Feasibility	A practical methodology must be feasible and able to be followed
Usability	A practical methodology must be usable and easily be applied and followed
Usefulness	A practical methodology must be useful and deliver the output as expected

5.3. GENERATING THE REQUIREMENTS SET FROM THE INDUSTRY

5.3.1 Design of Data Collection Protocol

As mentioned in Section 5.1, the research method selected in this phase of research is survey guided with semi-structured interviews. Due to the

nature of the information to be sought, the data collection method involves conducting survey with senior management staff from the selected companies to gather the required information. Figure 16 shows the structure of the data collection protocol.

First, the information to be sought is compiled. Second, the Interview questionnaire is generated and, third, the criteria for selecting the participating companies are generated and potential companies are selected. Forth, results generated from the case studies are then analysed and finally, the findings are presented in a way that it can be used to form the requirements set for the PSSE methodology.

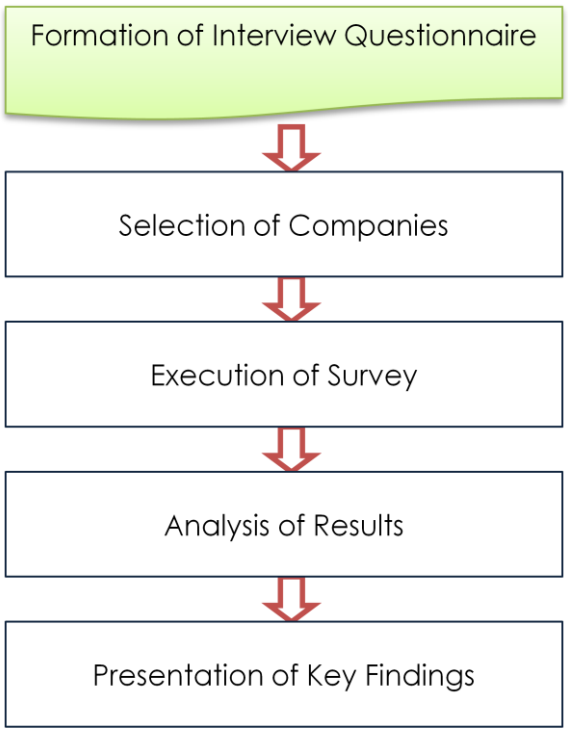


Figure 16: Structure of the Data Collection Protocol for Establishing Requirements Set from Industry

5.3.2 Formation of the Interview Questionnaire

As discussed in Section 5.1, the information to be sought during this stage of research is to support the execution of phase 1 of the research programme (Section 4.4.3) and to gather information concerning the content and delivery mechanism of the PSSE methodology preferred by the Singapore manufacturing industry. The questionnaire used in the survey therefore has been developed with the intention to gather knowledge in the following areas:

- Current services provided by manufacturing and the reasons for moving towards Servitization
- Awareness of the concept of PSS and Servitization in the industry
- Service strategy and new services to be provided by the manufacturers from the competitiveness point of view
- Possible tools and methodologies used in designing service if applicable
- Preferred content and delivery mechanism of the new PSSE methodology

As shown in Table 8, the questionnaire consists of a set of open-ended questions which are designed to capture above mentioned information. The questionnaire is to be presented to the interviewee during the face-to-face interview and the questionnaire will be filled in by the researchers after each in-depth discussion with the interviewee.

5.3.3 Selection of Participating Companies

The companies that participated in this phase were industrial partners chosen from a database for the Singapore Institute of Manufacturing Technology (SIMTECH). These companies have either engaged

SIMTECH in helping them to develop new products or have upgraded their manufacturing process capabilities.

Table 8: Interview Questionnaire

PSSE Interview Questionnaire
1. What are the existing services provided by your company, and why are you providing these services? 2. Do you have any intentions to include more new services in your current business? If yes, why and what services do you intend to provide? 3. Do you use any methodologies or tools to assist you in the planning of new services? Did you integrate service design in your overall corporate strategy? 4. Do you think Product-Service Mix offering is a competitive business strategy? 5. Are you aware of the concept of Product Service System (PSS) and Servitization? 6. Do you take into consideration reducing environmental impact when designing a new service/PSS strategy? Is going green vital for the company's future survival? 7. Do you think there is a need to develop a new methodology to help company in assessing the competitiveness of the new service oriented strategy, assuming currently there isn't any such methodology available? 8. What contents of the methodology would you prefer? (i.e. identify current business problems, identify future opportunities, internal and external drivers assessment, SWOT analysis, service design process, analysing critical manufacturing areas to support new services etc.) 9. Do you prefer the methodology to be delivered via facilitated workshop or online software tools, and why? 10. What are the factors that would affect your decision making process when come to the adoption of a new service/PSS strategy? (i.e. cost of investment, cost of maintenance, customer acceptance, service design process, product take back and others) 11. Would you like to participate in the testing of the new methodology?

The process used in engaging the companies for the survey is as follows:

First, the ten companies involved in this survey were selected from the client database of SIMTECH. The companies were selected based on the following criteria:

- The company must have offices registered in Singapore, however, their manufacturing facilities can be in or outside Singapore
- The company must be either the product owner or product manufacturer of at least one of their selling products
- The company is preferably to be selected from different industry sectors, providing either B2C or B2B businesses or both, and preferably with products representing different stages of their product life cycle
- The company must be already currently providing some forms of services and have the intention to provide more services
- The researcher must have close contact with the management of the company as well as having good knowledge about their product and processes.
- Products manufactured by the selected companies should be representing different phases of the product's life cycle curve

Second, the researcher will then brief the management of the companies about the intentions of engaging them in this survey via telephone, email or face to face appointment.

Based on the criteria stated above, a total number of 10 companies have been selected to participate in this round of research. As shown in

Figure 17, the life cycle status of the products manufactured by the ten selected companies is evenly distributed along the product development curve. This has made the group of selected companies the right size and ideal candidates for conducting the survey, and will result in an understanding their intention in moving towards Servitization as well as their requirements in a new PSSE methodology from a holistic perspective. A brief profile of the selected companies is provided in Table 9. Out of which, six companies have manufacturing facilities in Singapore. All companies involved in the survey are currently providing some form of services on top of the products they have manufactured and have the intention to provide more services in the future. Figure 17 illustrates the product life cycle profile of the selected companies which are evenly distributed along the product life cycle.

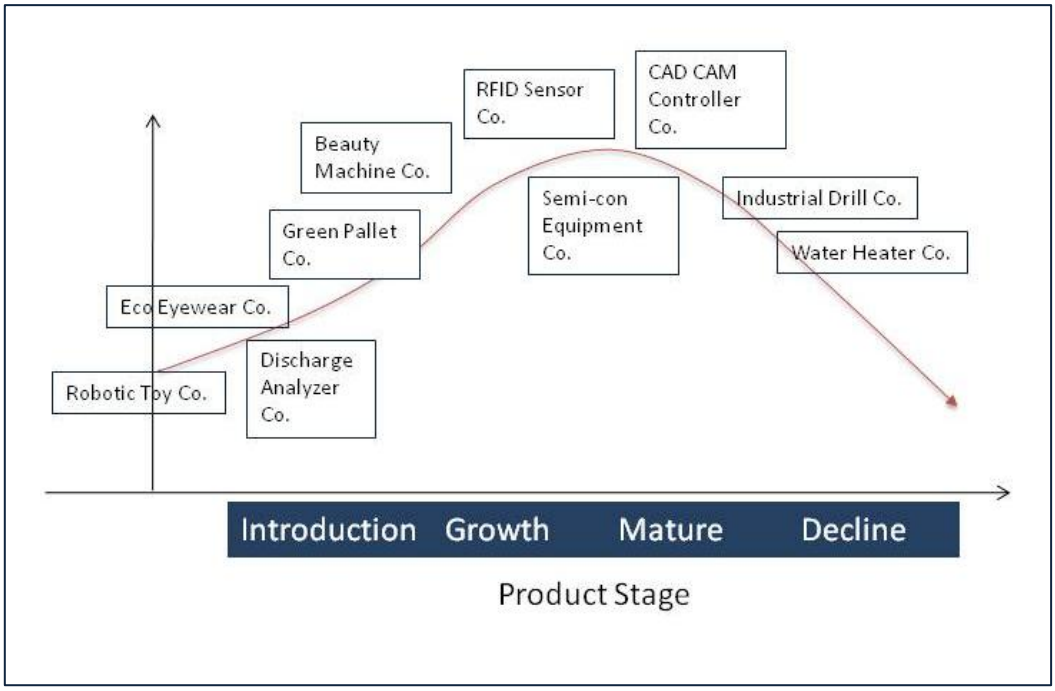


Figure 17: Product Life Cycle Profile of the Selected Companies

Following is the brief description of the background of the selected companies.

Company 1: Robotic Toy Co.

Robotic Toy Co is a new start-up company. It designs and develops a range of robotic toys targeted at a teenager age range. The proposed business model is to provide orders via the internet which allow customers to select their own customised design from the web. Users can pick different designs for the body parts of the robot, including head, arms and body etc. and select their own robot travelling route. Upon receiving the order, the company will then assemble the robot according to the customised specification and pre-programme the route and movement of the robot before delivering it to the customer.

Company 2: Eco-eyewear Co.

Eco-eyewear Co. designs, manufactures, and sells optic products and has been in the business for more than 20 years in Singapore. Their product range includes eyewear for consumers. In order to improve the company's image and keep up with competition, they have engaged actively in R&D and launched the world's first eco friendly glasses to the market. The company's latest range of products focuses on using recycled polymers to make the frames of reading glasses. This new eco friendly eyewear product has resulted in the company winning many international design awards.

Company 3: Discharge Analyser Co.

Discharge analyser Co. specializes in developing new and reliable electrical technologies in the area of partial discharge inspection and testing. It provides an inspection service using Infrared Thermograph technology. They have a strong client base of more than 50 customers from Singapore, Malaysia and China using their services.

Company 4: Green Pallet Co.

Green Pallet Co. has been in the timber industry for over 20 years and has grown into one of the largest manufacturers of high quality wooden pallets, boxes and crates in Singapore. As part of its ongoing efforts to reduce waste and to protect the precious timber resources of the earth, Green Pallet Co. has established Singapore's first wood waste recycling plant equipped with a highly automated system from Germany to produce a series of Technical Wood products.

Company 5: Beauty Machine Co.

Beauty Machine Co. designs and manufactures its own range of hair care products (i.e. hair dryers and hair irons), machines (i.e. mist and steaming machines) and accessories (i.e. hair clips) for salons and end consumers. It has manufacturing plants in Malaysia and China. Its current services include providing sourcing services to foreign companies outside Singapore to buy or sell products both in and out of China.

Company 6: RFID Sensors Co.

RFID Sensors Co. is a new start-up company focuses mainly on providing RFID solutions for hospital. It designs and manufactures RFID related medical products. It specialises in producing medical products for the monitoring of bio-signals (i.e. body temperature, heart rate and blood pressure etc.) for both hospital and consumer applications. Part of their services include providing advanced wireless Integrated Sensing System, to hospitals for tracking the real time location and for monitoring the vital signs of patients.

Company 7: CADCAM Controller Co.

CADCAM Controller Co. is one of the world's leading suppliers of advanced CADCAM solutions for the manufacturing industry. The South East Asia branch, which is the head quarters, is based in Singapore and provides professional manufacturing process services to the Aerospace and Medical technology industry in Singapore.

Company 8: Semi-con Equipment Co.

Semi-con Equipment Co. provides printed circuit board, assembly, manufacturing and equipment design services. It designs and builds semi-conductor equipment under its own brand, as well as providing value-added services such as materials management and engineering prototype development to the industrial equipment market. The company's business concept has been moving from 'Product Oriented PSS', to 'Use Oriented PSS/ and they are currently exploring opportunities in developing result oriented PSS, using 3D optic imaging equipment for wire bond inspection.

Company 9: Industrial Drill Co.

Industrial Drill Co used to be a distributor of tools and DIY products, and over the last few years has decided to design and manufacture it own products; One of its first designed products was the Industrial Cordless Drill. The company has the intention to market the product in two different business models; first to sell it directly to end consumers and second, to rent it out in large volume to local contractors, by encouraging them to use their products. The company also offers customer the opportunity to trade their old products from other brands for their new cordless drill.

Company 10: Water Heater Co.

Water Heater Co. is the first water heater company in Singapore. The company was founded in 1969, and designs, manufactures, distributes and sells electrical instant water heaters. As the water heater became commoditized and the sales became stagnant, the company has decided to provide more services to boost their sales. Apart from re-structuring its service unit, the company currently is working with developers to look into providing total solution, for example, providing centralising heating services for swimming pool, washing and showering etc.

Table 9: Brief Profile of the Participated Companies

No	Company Name	Business Type	Existing Services Provided	Manufacturing Facilities
1	Robotic Toy Co.	B2C	Nil	Singapore
2	Eco Eyewear Co.	B2C	Product Warranty	Singapore
3	Partial Discharge Co.	B2B	Product Warranty, Maintenance, Training	Singapore
4	Green Pallet Co.	B2B	Product Warranty, Installation and Repair	Singapore
5	Beauty Equipment Co.	B2B, B2C	Product Warranty, Training, Maintenance and Repair	China
6	RFID Sensors Co.	B2B, B2C	Consultancy in providing total solution, Maintenance	Singapore
7	CADCAM Controller Co.	B2B	After sales support, Consultancy	UK
8	Semi-con Equipment Co.	B2B	Consultancy in providing total solutions in medical equipment fabrication	Singapore
9	Industrial Drill Co.	B2B, B2C	Product Warranty, Product Take Back and Trade in	China
10	Water Heater Co.	B2B, B2C	Product Warranty, Installation and Repair	Singapore

5.3.4 Execution of the Survey

The execution of the survey was carried in the following manner:

First, an appointment was made with the company via email or telephone to fix the venue for the interview. As the semi-structured interviews would be conducted in a causal manner, thus, the venue would be fixing either in an office of the key management members of the company or at a coffee house (e.g. Star Bucks).

Second, prior to interviews, the researcher would compile the profile of the companies together with the products that they are currently manufacturing together with a list of services that are provided by the companies.

Third, during the interviews, the researcher would lead the discussion by going through the questions inside the Interview Questionnaire (as shown in Table 8), and record the answer given by the interviewee using the questionnaire designed for this survey. The design of the questionnaire can be found in Appendix A.

Forth, for an interviewee who had never heard of the concept of PSS and Servitization, the researcher would then do a short presentation to ensure that the interviewee has sufficient knowledge about PSS and Servitization in order to continue with the discussion.

Summary of the key information generated from the survey is provided in Tables 10.

Table 10: Summary of Results of the Survey

Questions	***Robotic Toy Co.***	***Eco-eyewear Co.***	***Discharge Analyser Co.***	***Green Pallet Co.***	***Beauty Machine Co.***
1. What are the existing services provided by your company, and why are you providing these services?	Nil	Product Warranty	Product Warranty, Maintenance, Training	Product Warranty, Installation and Repair	Product Warranty, Training, Maintenance and Repair
2. Do you have any intentions to include more new services in your current business? If yes, why and what services do you intend to provide?	YES To create unique business model	YES To improve sales	YES Productization. This company started out as a service provider, now owning their own testing equipment	YES To improve competitiveness and to establish green image for the company	YES To encourage more salon using their machine To promote the sales of the supporting beauty wet products
3. Do you use any methodologies or tools to assist you in the planning of new services? Did you integrate service design in your overall corporate strategy?	NO	Yes. Own in-house methodology is when starting a new service strategy	NO	NO	NO

4. Do you think Product-Service Mix offering is a competitive business strategy?	YES	YES	YES	YES	YES
5, Are you aware of the concept of Product Service System (PSS) and Servitization?	YES	NO	NO	NO	NO
6. Do you take into consideration reducing environmental impact when designing a new service/PSS strategy? Is going green vital for the company's future survival?	NO	YES. The MD has strong environmental consciousness, the new range of products is mainly made with recycled material	NO, but service provided will indirectly reduce the environmental impact	YES, to recycle the material used for pallet design	NO
7. Do you think there is a need to develop a new methodology to help company in assessing the competitiveness of the new service oriented strategy, assuming currently there isn't any such methodology available?	YES	YES	YES	YES	YES
9. Do you prefer the methodology to be delivered via facilitated workshop or online software tools, and why?	Online Tool	Facilitated Workshop	Facilitated Workshop	Online Tool /Facilitated Workshop	Facilitated Workshop

10. What are the factors that would affect your decision making process when come to the adoption of a new service/PSS strategy?	Customer Acceptance	Cost of Investment	Product must be able to perform and deliver accurate result	Customer Acceptance	Customer Acceptance
11. Would you like to participate in the testing of the new methodology?	NO	YES	YES	NO	YES

Questions	***RFID Sensors Co.***	***CADCAM Controller Co.***	***Semi-con Equipment Co.***	***Industrial Drill Co.***	***Water Heater Co.***
1. What are the existing services provided by your company, and why are you providing these services?	RFID Sensors Co.	Product Warranty	Product Warranty, Maintenance, Training	Product Warranty, Installation and Repair	Product Warranty, Training, Maintenance and Repair
2. Do you have any intentions to include more new services in your current business? If yes, why and what services do you intend to provide?	YES To be more internationally competitive and improve customer relationship	YES To become one stop solution in providing professional service in machine tool	YES To expand the current scope of business from contract manufacturing into selling solution by using their own	YES To improve sales and encourage more customers to switch brand	YES To widen the scope of business through selling heating solution

			equipment		
3. Do you use any methodologies or tools to assist you in the planning of new services? Did you integrate service design in your overall corporate strategy?	NO	NO	NO	NO	NO
4. Do you think Product-Service Mix offering is a competitive business strategy?	YES	YES	YES	YES	YES
5, Are you aware of the concept of Product Service System (PSS) and Servitization?	NO	NO	NO	NO	NO
6. Do you take into consideration reducing environmental impact when designing a new service/PSS strategy? Is going green vital for the company's future survival?	YES, to recycle the PCB inside old RFID tags	NO	Yes. In the semi-conductor industry, meeting environment green standard is very important	NO	NO
7. Do you think there is a need to develop a new methodology to help company in assessing the competitiveness of the new service oriented strategy, assuming currently there isn't any such methodology available?	YES	YES	YES	YES	YES

9. Do you prefer the methodology to be delivered via facilitated workshop or online software tools, and why?	Online Tool	Facilitated Workshop	Facilitated Workshop	Online Tool	Facilitated Workshop
10. What are the factors that would affect your decision making process when come to the adoption of a new service/PSS strategy?	Product must be able to deliver promised results	Cost of Investment	Customer Acceptance	Cost of Investment	Cost of Investment
11. Would you like to participate in the testing of the new methodology?	YES	YES	YES	NO	YES

5.3.5 Presentation of Key Findings

This section provides a description of the key findings.

The Concept of PSS

As shown in Table 10, almost all the companies interviewed were not aware of the concept of PSS. The only interviewee who was aware was the founder of the Robotic Toy Co. who is a retired professor from one of the local universities in Singapore. Prior to his retirement, he had conducted some research projects in PSS. Nonetheless, although most of the companies were not aware of the concept of PSS and Servitization, they did agree, that providing value added service is becoming more important and is crucial for maintaining their long term success.

Finding 1	PSS is generally an unknown concept in Singapore.

PSS as a Competitive Strategy

All companies agreed that providing more services will increase the competitiveness of the company. In addition, product and service fix offering is generally regarded as a potential competitive strategy to the Singapore manufacturing company. All the companies being interviewed have the intention to provide more new services in order to provide better customer service and increase competitiveness.

Finding 2	Providing more services to support the product was generally perceived as a way to increase the competitiveness of the company and product-service mix offerings like PSS are generally regarded as a potential competitive strategy

Methodology for Assessing the Competitiveness of a New PSS Strategy

Most of the companies interviewed were not aware of any new service design tools or methodologies. However, they did agree that it would be useful to make use of some kind of tools or methodologies to assess the competitiveness of a new PSS strategy before adopting it. Thus, they supported the idea of developing a new methodology to assess the competitiveness of the new service strategy and would like to implement it, if it is good and practical.

Finding 3

All companies interviewed did agree that a good and practical methodology would be helpful in assessing the competitiveness of a new PSS strategy before adopting it.

Identification of Critical Success Factors

All the companies interviewed felt that it is important to identify the critical success factors before implementing a completely new service strategy. Although they felt that providing good products (products able to deliver the promised services) and services (services able to fulfil customer's needs) is crucial to start a PSS strategy, understanding the customer's needs and acceptance is the most critical success factor.

Finding 4

Most companies agreed that it is Important to identify the critical success factors when making decisions to adopt a new strategy. The top three critical factors being identified were to understand the customer's needs and acceptance (50%), the cost of investment (30%) and for the products to be able to deliver

promised service (20%).

Preferred Delivery Mechanism of the PSSE Methodology

When asking whether the methodology is to be delivered via a facilitator in a form of workshop or via online software, as shown in Table 10, eight of the companies interviewed preferred the methodology to be delivered via a facilitated workshop. The online tool is generally regarded as unreliable and not professional enough, and in addition, companies are not confident enough to implement the result produced by the online tool to make important decisions.

Generally, they preferred to work with a consultant in order to understand their current business strategic position and on how a new service strategy can help them to stay more competitive. The companies that have opted for the online tool were new start up companies with a junior management team and tended to be too busy to go through a facilitated workshop to make business decision. They preferred the methodology to come in a form of online software tool so that they can use it as and when time is permissible. One of the junior executives put it this way: "Own time, own target".

Finding 5 80% of the companies interviewed preferred the PSSE methodology to be conducted via a facilitated workshop. The online tool is generally regarded as unreliable and not professional enough for decision making.

5.4. GENERATING THE FINAL REQUIREMENTS SET FOR PSSE METHODOLOGY

As illustrated in Figure 12, the final requirements set for the PSSE methodology are generated by combining the knowledge gained from literature regarding the set characteristics of a good methodology and the characteristics set of a practical methodology (Section 5.2), and the findings generated from industrial case studies regarding the content and delivery mechanism preferred by the Singapore industry (Section 5.3), and the objective of the PSSE methodology, (Section 4.2). The final requirements set are presented in Table 11.

Most importantly, the new PSSE methodology must consist of characteristics of a good methodology: first, *Scope and Objectives* to ensure that the objectives and scope of the project is clearly defined; second, *Step-by-Step Structure* to allow the users to follow through the process in a step-by-step approach; third, *Tools and techniques* to facilitate the discussion process; forth, *Platform of Participation* to allow individual and group discussions; fifth, *Project management* to ensure the project is adequately resourced and works to a clear timescale; sixth, *Template of Documentation, producing* templates to ensure that data and assumptions can be captured in a well designed document for future usage; and last but not least, *Expected Deliverables, the* expectation to ensure desired outcomes are being produced at each stage.

The PSSE methodology must also be feasible – able to be followed, usable – easy to use and useful – able to deliver the expected outcome. It shall be delivered via a facilitated workshop which is most preferred by industry and consists of some of the following processes:

- ✓ PSS competitive analysis; these include Servitizability assessment to ensure that the company is able to deliver the PSS strategy and review of a competitive strategy to identify any competitive gaps
- ✓ PSS activities design and identification of critical resources to support it
- ✓ Understanding the customer's needs and acceptance to ensure the new PSS strategy is able to fulfill customer needs
- ✓ Identification of critical success factors

5.5. CHAPTER SUMMARY

This chapter described the detailed execution of phase 1 of the research programme and presents the research method used to establish the requirements set for the PSSE methodology. A research data collection protocol has been developed to collect data from industry. The final requirements set for the PSSE methodology are a combination of knowledge gained from literature regarding the characteristics of a good and practical methodology (Section 5.2) and findings generated from industrial case studies regarding the content and delivery mechanism preferred by the Singapore manufacturing industry (Section 5.3). The final requirements set, as shown in Table 11, will be used as the fundamental guideline in selecting the existing potential methodologies to form the conceptual base of the PSSE methodology in phase 2 of the research programme. A detailed description of phase 2 will be provided in the next Chapter.

Table 11: Final Requirements Set of the PSSE Methodology

Number	Requirements	Description
	Characteristics of a Good PSSE Methodology	
1	Scope and objectives	Clearly defined scope and objectives
2	Step-by-Step Structure	Well defined procedures and step by step structure
3	Tools and techniques	Simple and easily understood tools and techniques
4	Platform for Participation	Platform to allow participation of groups and discussion
5	Project management	Provide project management, change management and analysis technique
6	Template for Documentation	Provide well written designed templates for results recording
7	Expected Deliverables	Clear defined outcome at each stage and final deliverables
	Characteristics of a Practical PSSE Methodology	
8	Feasibility	The methodology must be able to be followed
9	Usability	The methodology must be easily applied and followed
10	Usefulness	The methodology must provide a useful output that met expectations
	Objective of the PSSE Methodology	
11	PSS Competitiveness Analysis	Process to assess the competitiveness of the new strategy
12	PSS Activities Design	Process to design PSS activities
	Preferred Content and Delivery Mechanism By the Singapore Industry	
13	Understand Customer Needs and Acceptance	Process to understand customer needs and assess customer acceptability
14	Assess Critical Success Factors	Process to identity and assess the competitiveness of the critical success factors of the new PSS strategy
15	Facilitated Workshop	Methodology to be delivered via facilitated workshop and presented in a facilitator Guide

CHAPTER 6: SELECTION & EVALUATION OF EXISTING POTENTIAL METHODOLOGIES

Chapter 5 discussed the process in generating the set requirements for the PSSE methodology. This chapter presents the results of phase 2 of the research programme. The objective of this phase of research is to select and evaluate existing potential methodologies against the requirements set listed in Table 11. Section 6.1 first presents the research method of this phase and then the overview of the existing methodologies relating to PSS and manufacturing strategies is given in Section 6.2. Section 6.3 discusses the results of the analysis of the existing methodologies against the requirements set and the detailed description of the most appropriate methodologies that can be used as a conceptual base to form the pilot PSSE methodologies is finally presented in Section 6.4. Section 6.5 presents the summary of this chapter.

6.1. PHASE 2: OBJECTIVE AND RESEARCH METHOD

The objective of the second phase of the research programme is to evaluate existing methodologies in order to select the most potential methodologies that can be used as a conceptual base to form the PSSE methodology (Section 4.4.4). A methodology can be defined as:

"a qualitative type of formal method which describes what steps to take, explains how each step should be performed and justifies why each step is taken" (Chandraprakaikul, 2008)

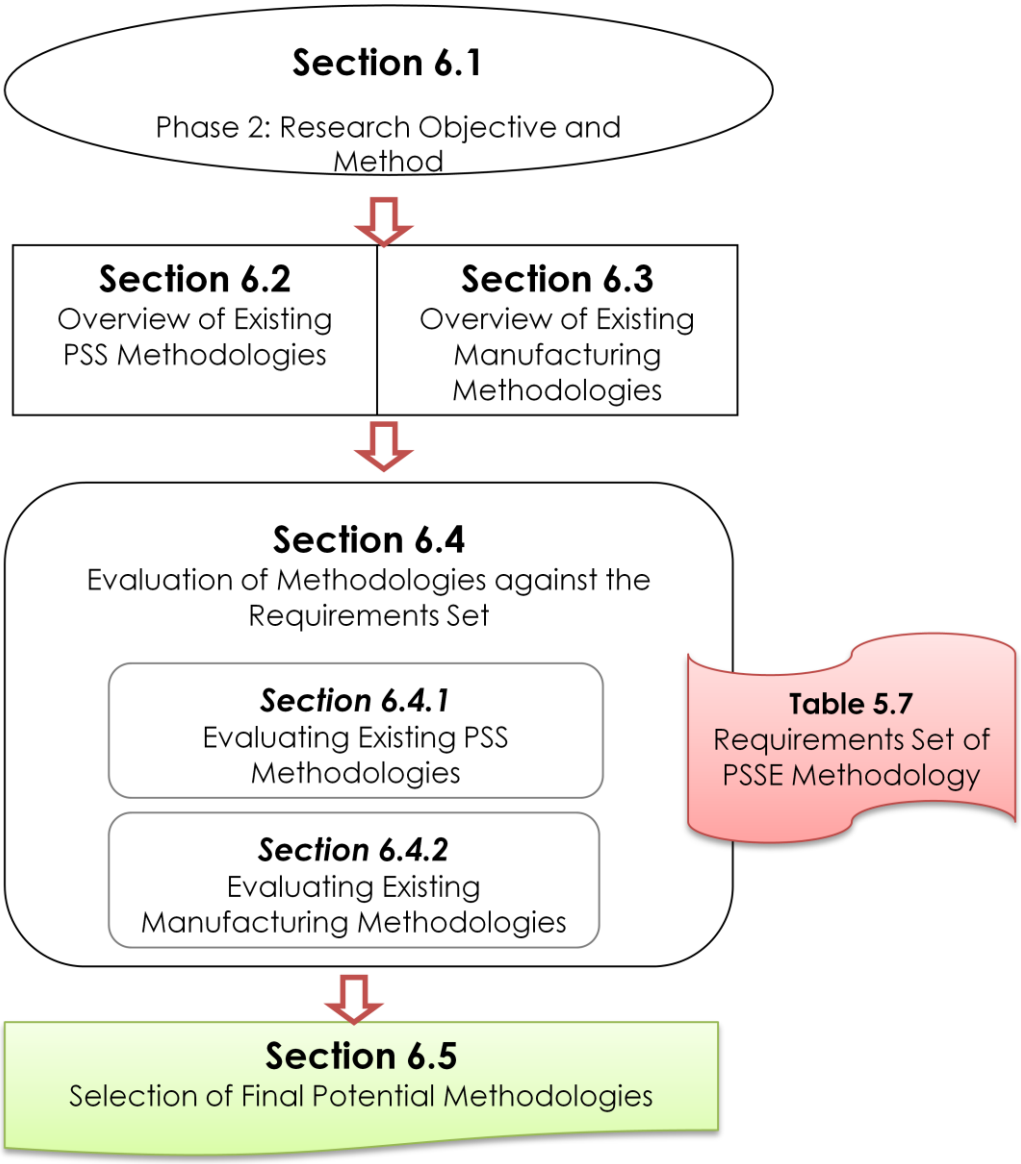


Figure 18: Overview of the Structure of Phase 2 of the Research Programme

As described in Section 4.4.2, the research method preferred in this phase is to study the existing methodologies available from the literature related to PSS and manufacturing strategy against the set requirements outlined in Section 5.4. The purpose is to identify and select the most suitable methodologies to form the conceptual base of the new PSSE methodology.

Thus, the research method used in this phase is to review research papers from the suitable research databases relating to PSS and manufacturing strategy. In order to provide a more holistic coverage of the study, apart from methodologies, this review also includes frameworks, tools and models.

This section described the objective and research method of Phase 2. The next section provides an overview of the existing PSS methodologies.

6.2. OVERVIEW OF EXISTING PSS METHODOLOGIES

This section presents an overview of the frameworks, tools and methodologies relating to PSS. The existing PSS frameworks, tools and methodologies (hereafter referred to as methodologies), are shown in Table 12. The following session provides a brief description of the methodologies being discussed in different perspectives of PSS.

6.2.1 Methodologies for Designing New PSS

In the area of design and development of a new PSS, there are a number of methodologies available in the literature, for example, Abdalla (2004), Brezet et al. (2003), MEPSS (2004), Kobashiya and Kumazawa (2007) and Yang et al. (2008) etc.

Abdalla (2004) presents a 7-step PSS development strategy using TRIZ – a Russian acronym for inventive problem solving. Its purpose is to improve

or design a new PSS using a systematic approach. The methodology concentrates on the system design of PSS, and does not take into consideration of the business and operation aspects of a PSS.

MEPSS - Methodology for Product Service System (MEPSS, 2004) is a 5-phase methodology developed by the European Commission under the 5th Framework Programme, to enable the European industry to develop PSS. The MEPSS toolkit was made available via a handbook and on the website www.mepss.nl.

Kobashiya and Kumazawa (2007) propose another 7 step procedural methodology to evaluate the technical elements of a reuse and leasing PSS business model. This methodology performs an analysis of business risk and PSS components in order to find out which components are the most suitable to be used in a PSS reuse and leasing business.

In the aspect of PSS model development, Yang et al. (2008) proposes an engineering methodology for software toolkit development by realizing product-oriented PSS and use-oriented PSS for consumer products by encompassing product lifecycle data, intelligent data unit and the service enabler.

6.2.2 Framework for Integrating PSS and Manufacturing

A number of frameworks developed for integrating PSS and manufacturing activities are available in the literature (William, 2005; Aurich et al., 2006; Lee et al., 2007; Panizzolo R, 2008).

William (2005) looks into the strategic management of PSS by presenting a method to analyse the competitive advantage of Close looped PSS. Lee et al. (2007) develop a framework, named IMPSS, for integrated manufacturing and PSS by integrating service operations into product life cycle using software infrastructure architecture based on semantic web

services. Aurich et al. (2006) develop a software framework for lifecycle management of technical PSS for manufacturer.

Panizzolo R (2008) proposes a methodology to measure the value of services provided to customers in manufacturing firms using QFD – Quality Function Deployment. This methodology also supports a what-if analysis to assess whether the implementation of new customer services would influence the firm's competitive positioning.

6.2.3 Performance Measurement of PSS

A number of the methodologies focus in evaluating the sustainability of a new PSS (Goedkoop et al., 1999; Luiten et al., 2001; Wong, 2004; Tukker, 2004a).

Goedkoop et al. (1999) propose a method to analyse the economic and ecological qualities of PSS by using V2 vector. Luiten et al. (2001) develop a sustainable PSS methodology by using the Kathalys method to describe the PSS activities. Wong (2004) develops a set of web-based PSS implementation tools based on case-based reasoning technique to study the sustainability performance of existing PSS case studies for the electronic consumer goods industry. This set of tools, together with the business cases used can be found on the website - www.sustainablepss.org.

Omann (2003) and Hammer (2004) developed a software tool based on Excel using multi criteria decision analysis (MCDA) to analyse the sustainability effects of the economic, environmental and social dimension of PSS. Tukker (2004a) further expands the concept of PSS by introducing eight types of PSS to represent the eight ways towards sustainability. This work is concluded from the project of SusProNet supported by the European Commission.

Table 12: Overview of Existing Frameworks and Methodologies Related to PSS

Author	Area of Focus	Output	Type
Yang et al. (2008)	Realizing product-oriented PSS and use-oriented PSS for consumer products by encompassing product lifecycle data, Intelligent Data Unit and the service enabler	Engineering methodology for Software Toolkit Development	Methodology
Panizzolo R (2008)	A methodology to measure the value of services provided to customers in manufacturing firms using QFD – Quality Function Deployment. The proposed methodology also supports a what-if-analysis able to assess whether the implementation of new customer services would influence the firm's competitive positioning.		Methodology
Lee et al. (2007)	Integrating service into product life cycle	IT Infrastructure framework based on Semantic web services	Framework
Kobayashi & Kumazawa (2007)	Determining whether a reuse PSS business should be started or not	Methodology for business decision making	Methodology
Aurich et al. (2006)	0. Implementation of systematic service design processes and specification of interfaces with existing product design processes 1. Life cycle oriented PSS planning 2. Integrated design based on predefined work packages (process modules) 3. PSS realization and feedback of service information into PSS planning	Framework for Life cycle oriented design of technical PSS	Framework

McAloone (2006)	Developing PSS Activities	Software tool using activity modelling cycle (AMC) modelling technique	Tool
Williams (2005)	Analysing the close looped PSS – competitive advantages	Strategic management of PSS	Concept & Case Study
Tukker (2004a)	Eight types of product service system: eight ways towards sustainability, experience from SusProNet	Eight types of product service system: eight ways towards sustainability, experience from SusProNet	Model
Wong (2004)	PSS Case study evaluation	Web based PSS implementation tool using Case-based reasoning technique for the consumer goods industry	Tool & Case Study
MEPSS (2004)	PSS project design, evaluation and implementation	Methodology for new PSS business development	Methodology
Mont (2004)	Exploring the concept of PSS to attain sustainability	Concept of using PSS to attain sustainability	Concept & Case Study
Hammer (2005)	Analysing sustainability effects of PSS – Economic, Environmental, Social dimension	Software tool based on Excel using multi criteria decision analysis (MCDA)	Tool
Abdalla (2004,2006)	Developing new PSS using the Theory of TRIZ	A 7-step PSS development strategy using TRIZ	Methodology
Weber et al. (2004)	Designing PSS activities	Model using property driven design (PDD)	Model
Omann (2003)	Evaluating the environmental, economic and Social dimension of the PSS case studies	Software Tool based on Excel using Multi criteria Decision Analysis (MCDA) for the Austrian	Tool

		companies	
Brezet et. al (2003)	Design eco-efficient service methodology by expanding on the product development process by	Eco-efficient service development process	Methodology
Bullinger et al. (2003)	Service engineering - Methodical development of new service products	Service engineering - Methodical development of new service products	Methodology
Morelli (2002)	The design of product/service systems from a designer perspective	The design of product/service systems from a designer perspective	Tool
Luiten et. al (2001)	Sustainable PSS methodology using the Kathalys method	Sustainable product-service systems: the Kathalys method	Methodology / framework
White et al. (1999)	Extended Producer Responsibility	Concept - Servicising – the quiet transition to extended producer responsibility	Concept & Case Study
Goedkoop et al. (1999)	Concept design of product and service mix	A method to analyse the economic and ecological qualities of PSS using V2 vector	Concept / Method

6.2.4 Methodology for Service Design of PSS

In designing service components for PSS, some researchers have attempted to provide new tools and methods to capture the service activities for PSS (Morelli, 2002; Brezet et al., 2003; Bullinger et al., 2003; McAloone, 2006).

Morelli (2002) approaches the design of the service components of a PSS from a designer perspective by using visual and graphic aided tools to present the service scenario of PSS.

Brezet et al. (2003) develop a methodology for the design of eco-efficient services based on the traditional product design methodology. Bullinger et al. (2003) use the concept of service engineering to develop a new service product for PSS methodically. Weber et al. (2004) develop a model using Property Driven Design (PDD) to describe PSS activities. McAloone (2006) conceptualizes PSS activities using Activity Modelling Cycle (AMC) modelling technique.

This section has provided an overview of the existing PSS methodologies. The next section will review the methodologies in the area of manufacturing strategy.

6.3. OVERVIEW OF EXISTING MANUACTURING METHODOLOGIES

This section provides an overview of the existing methodologies in the area of manufacturing strategy formulation.

As shown in Table 13 and Table 14, these methodologies can be broadly divided into two main categories. The first category is the methodologies that are dealing with the strategic decision making of manufacturing activities Internal to an organisation, i.e. business process improvement, and the second category deals with strategic decision making external to an organisation, i.e. supply chain strategic positioning.

6.3.1 Methodologies Internal to an Organisation

A methodology that is internal to an organisation usually deals with internal processes. For example, as shown in Table 13, Tan & Platts (2005) build an action plan for effective strategic action planning; Adesola

(2002) proposes a methodology called MIPIM for business process improvement; Probert et al. (2000) define a 7-step methodology for performance monitoring and evaluation of Technology Management and Assessment; Crowe & Cheng (1996) develop a Manufacturing strategy planning methodology using QFD for Manufacturing make or buy policies and Platts (1990) proposes a new model for Manufacturing audit.

6.3.2 Methodology External to an Organisation

The existing methodologies concerning external strategic positioning are mainly contributed by Baines et al (2005), The Manufacturing Foundation et al.(2006), Lim(2007) and Chandraprakaikul (2008). Baines et al. (2005) define a five-step methodology in the form of workbook, and Lim (2007) further develop it to a six-stage methodology using Excel software for the SMEs in Singapore by adopting a resource-based view strategy.

Based on work done by Baines and Lim, Chandraprakaikul (2008) further develops a procedural 5-stage methodology in the form of workbook for strategic positioning within global supply chains by taking a holistic approach to consider all supply chain issues relating to a manufacturer. One of the common characteristic of these methodologies is that they are all developed based on a structured and procedural step by step process.

Table 13: Overview of existing methodologies in the area of Manufacturing Strategy Formulation (Internal to Organisation)

Source: Adesola (2007); Lim (2007); Chandraprakaikul (2008)

Author	Area	Stages	Output	Delivery Process
Tan & Platts (2005)	Effective Strategic action planning	1. Build a model of the problem situation 2. Generate action plans 3. Evaluate action plans	Action plan	Workshop
Adesola (2002)	Methodology for business process improvement - MIPIM	1. Understanding the business needs 2. Understanding the process 3. Model and analysis 4. Redesign process 5. Implement new process 6. Assess new process and methodology 7. Review new process	Framework	Facilitated Workshop
Probert et al. (2000)	Technology Management and Assessment	1. Developing a strategic vision, 2. Setting objectives 3. Crafting the strategy to achieve the respective vision and objectives 4. Implementing and executing the selected strategy 5. Performance monitoring and strategy evaluation	Performance monitoring & evaluation	
Crowe & Cheng (1996)	Manufacturing strategy planning using QFD	1. Define the business environment 2. Formulate functional strategy 3. Formulate manufacturing priority 4. Define implication in terms of manufacturing tasks 5. Constraints / limitations 6. Make or buy policies	Manufacturing make / buy policies	Workshop
Hofer and Schendel, 1978	Seven Stages of Prescriptive Strategy Formulation	1. Strategy Identification 2. Environmental Analysis 3. Resource Analysis 4. Gap Analysis 5. Strategic alternatives 6. Strategy Evaluation 7. Strategy Choice	Strategic Choice	

Table 14: Overview of existing methodologies in the area of Manufacturing Strategy Formulation (External to Organisation)

Author	Area of Focus	Stages	Output	Delivery Process
Chandraprakaikul (2008)	Global Supply Chain Positioning for manufacturer	1. Issue analysis 2. Mapping current supply chain Position 3. Future analysis 4. Configuration analysis 5. Selection and action plan	Supply chain action plan	Workshop
Lim (2007)	Supply Chain Strategic Positioning Strategy Formulation for Singapore SMEs	1. Scope issues 2. Identify activity and resource landscape 3. Identify significant activities and critical resources 4. Review competitive strategy 5. Alignment check between performance and strategy 6. Formulate strategy	Supply chain prioritised action	Workshop
The Manufacturing Foundation et al. (2006)	Offshoring	1. The facts 2.Your competitive position 3. Establishing your priorities 4. Reducing costs & managing the threat 5. Seizing the offshore opportunities 6. Securing your future 7. Action plan	Offshoring action plan /	Workshop
Baines et al. (2005)	Manufacturing Strategic Positioning Formulation	1.Scope issue 2. Identify key decision criteria 3. Identify activity landscape 4. Assess impact 5. Consolidates Outcome	Manufacturing strategic prioritised actions	Workshop
Probert et al. (1997)	Make or buy strategy formulation	1. Initial business appraisal 2. Internal / external analysis 3. Generation and evaluation of strategic options 4. Choosing optimal strategy	Manufacturing make buy strategy	

6.4. EVALUATING THE METHODOLOGIES AGAINST THE REQUIREMENTS SET

The purpose of this Section is to provide a detailed description of the design and execution of the evaluation process of the existing methodologies against the established requirements set.

6.4.1 Design of the Evaluation Criteria

All the methodologies are analysed against the set requirements according to a rating scale of 0 – 2:

- Scale 2 means it can fulfill exactly
- Scale 1 means it can fulfill partially or can be used with modification, or has been demonstrated with case studies
- Scale 0 means the methodology is not really intended for this purpose or data is not available

A brief description of the analysis of the existing methodologies in the category of PSS methodology and manufacturing strategy against the requirements set using the above rating scale is provided in the following sections.

6.4.2 Evaluating Existing PSSE Methodologies

As one of the requirements for the development of the PSSE methodology is to develop the methodology based on a step by step structure, the methodologies fulfilled this basis requirement are first selected from the list provided in Table 12 for further evaluation. The selected potential methodologies are briefly presented in Table 15:

- Kobayashi and Kumazawa (2007) - Strategy to start Re-use/ Leasing Business

- Aurich et al. (2006) - Framework for Lifecycle Management of PSS
- MEPSS (2004) - Methodology for PSS Design
- Abdalla (2004) - PSS Development Strategy using TRIZ
- Brezet et al. (2003) - Eco- efficient Service Development Process
- Luiten et al. (2001) - Sustainable PSS Methodology using the Kathalys Method

These selected methodologies are first evaluated against the characteristics set for a good methodology, namely, *Scope and Objectives, Step-by-Step Structure, Tools and Techniques, Platform for Participation, Project Management, Template for Documentation and Expected Deliverables*, in the following sections:

Scope and Objectives - As all the methodologies were related to PSS, in terms of scope and objectives, they were all partially fulfilled in the first place. However, as shown in Table 15, judging from the stages provided by both Kobayashi and Kumazawa (2007) and MEPSS (2004), they appeared to have a more relevant content to the requirement of the new PSSE methodology, therefore a score "2" has been given to these two methodologies in this category while the rest of the methodologies have a partially fulfilled score of "1".

Step-by-Step Structure – As shown in Table 15, all these methodologies were first selected from Table 12 based on the fact that they have all adopted a step-by-step structure with clearly defined stages; therefore all of them have scored a full mark of "2" in this category.

Tool and Techniques - All methodologies have shown some form of techniques and providing evidence in adopting different tools in their methodologies. All of these methodologies are relevant to PSS and as a result their tools and techniques are also mostly relevant to the

development of the new PSSE methodologies too. Thus a partial fulfilled score of "1" was given to all the methodologies in this category.

Platform for Participation – The stages in these methodologies have implied some form of participation from the users, therefore apart from MEPSS (2004), which was given a "2" by showing evidence of providing a platform for participation in its workbook instruction (MEPSS,2004c), all other methodologies were given a partially fulfilled score of "1" in this category.

Project Management – Apart from MEPSS (2004), which has demonstrated evidence in providing resources in managing project on its web tool (MEPSS, 2004a,b), most of these methodologies did not provide information on whether they have provided resources for project management in their methodologies, therefore, apart from MEPSS (2004), most of the methodologies scored a "0" in this category

Template for Documentation – Apart from MEPSS (2004), which has made available the template for all the worksheets it used on the web, most of the methodologies did not provide information on whether they have designed a template for documentation. Therefore, apart from MEPSS (2004), most of the methodologies scored a "0" in this category.

Expected Deliverables – Due to a lack of information, it was rather difficult to justify whether these methodologies have indeed delivered their expected outcomes therefore a partially fulfilled score of "1" is given to all of the methodologies in this category.

As shown in Table 16, MEPSS (2004) has a high score of "12" in fulfilling the requirements set for being a good methodology.

Table 15: Selected Potential Methodologies Related to PSS

Author	Area	Stages	Output	Delivery Mechanism
Kobayashi and Kumazawa (2007)	Strategy to start re-use/ leasing business	1.Selecting life cycle options 2.DFV considering product life cycle 3. LCS 4. Business risk evaluation 5. PSS component analysis 6. Acceptability analysis 7. Acceptability simulation	Re-use - Leasing	Business Analysis Report
Aurich et al. (2006)	Framework for Lifecycle Management of PSS	0. Implementation of systematic service design processes and specification of interfaces with existing product design processes 1. Life cycle oriented PSS planning 2. Integrated design based on predefined work packages (process modules) 3. PSS realization and feedback of service information into PSS planning	Frame-work	Software tool
MEPSS (2004)	Methodology for PSS design	1. Strategy analysis 2. Exploring opportunities 3. PSS Idea development 4. PSS concept design 5. Development and implementation of PSS project		Handwork/Web tool / Workshop
Abdalla (2004)	PSS development strategy using TRIZ	1. Identify opportunity – main problems 2. Identify specific PSS characteristic 3. Map characteristic to problems 4. Develop PSS concept 5. Implement solution – method/tools 6. Evaluate system		
Brezet et al. (2003)	Eco-efficient Service development process	1. Exploration 2. Policy Formulation 3. Idea Finding 4. Strict Development 5. Realization 6. Evaluation	Action Plan/ Tools /	Delivery Process not known
Luiten et. al (2001)	Sustainable PSS methodology using the Kathalys method	1. Future Exploration 2. System Design 3. Product/Service Specification 4. Drawing in Details and Testing 5.Implementation	Case study	Project Implementation

The requirements set for a practical methodology, as presented in Section 5.2.2, are Feasibility, Usability and Usefulness. The criteria of the evaluation in this category look for evidence and data in the testing of the methodologies in using actual industry applications against the characteristics of a practical methodology.

Feasibility, Usability and Usefulness - As MEPSS (2004) is the only methodology that has shown evidence of using actual industry applications (www.mepss.nl), it was the only methodology that has given a partially fulfilled score of "1" in all three requirements in this category.

PSS Competitiveness Analysis – All the selected methodologies did not show evidence of providing functions for competitiveness analysis. Therefore, apart from MEPSS (2004) which has provided some form of competitiveness analysis in its methodology, and has been given a partial score of "1", all of the other methodologies were given a "0" in this category.

PSS Design Activities - Most of the selected PSS methodologies provided basic PSS design activities stages, therefore they have fulfilled the basic requirements of this category and were given a full score of "2".

Understand Customers Needs and Acceptance – As understanding customer needs and acceptance is one of the most important activates of PSS design, most of the PSS methodologies evaluated fulfilled the requirements. Therefore, a full score of "2" was given to all the methodologies in this category.

Assess Critical Success Factors – As assessing critical success factors is normally part of the risk assessment before implementing a new PSS, a partial fulfilled score of "1" was given to all the methodologies in this category.

Table 16: Comparison of Existing PSS Methodologies Against the Requirements Set for the PSSE Methodology

Author	Kobashiya & Kumazawa (2007)	Aurich et al. (2006)	MEPSS (2004)	Abdalla (2004)	Brezet et al. (2003)	Luiten et. al (2001)
Characteristics Set of the Structure for a Good Methodology 2 - fulfil exactly, 1 – fulfil partially or can be used with modification, 0 - data not available						
Scope and objectives	2	1	2	1	1	1
Step-by-Step Structure	2	2	2	2	2	2
Tools and Techniques	1	1	1	1	1	1
Platform for Participation	1	1	2	1	1	1
Project Management	0	0	2	0	0	0
Template for Documentation	0	0	2	0	0	1
Expected Deliverables	1	1	1	1	1	1
Score (max 14)	**7**	**6**	**12**	**6**	**6**	**7**

Characteristics Set of the Applicability for a Good Methodology 2 - fulfil exactly, 1 – demonstrated with case study, 0 - data not available						
Feasibility	0	0	1	0	0	0
Usability	0	0	1	0	0	0
Usefulness	0	0	1	0	0	0
Score (max 6)	**0**	**0**	**3**	**0**	**0**	**0**
Activities of the PSSE Methodology 2 - fulfil exactly, 1 – fulfil partially or can be used with modification, 0 - data not available						
PSS Competitiveness Analysis	0	0	1	0	0	0
PSS Activities Design	2	2	2	2	1	2
Score (max 4)	**2**	**2**	**3**	**2**	**1**	**2**
Content and Delivery Mechanism Preferred by Singapore Industry 2 - fulfil exactly, 1 – can be used with modification, 0 - data not available						
Understand Customer Needs and Acceptance	2	2	2	2	2	2
Assess Critical Success Factors	1	1	1	1	1	1
Facilitated Workshop	0	0	2	0	0	0
Score (max 6)	**3**	**3**	**5**	**3**	**3**	**3**
Final Rating Score (max 30)	**13**	**11**	**24**	**11**	**10**	**12**

Facilitated Workshop - MEPSS (2004) is the only methodology that was designed to be used in a facilitated workshop, and as a result it was the only methodology that has been given a full score of "2".

In summary, MEPSS (2004) has emerged as the highest potential PSS methodology with a total score of 24 from all of the categories discussed above. The second highest potential methodology is Kobayashi & Kumazawa (2007) with a score of 13 and followed by both Abdalla (2004) and Aurich et al. (2004) with a score of 11 each.

6.4.3 Evaluating Existing Manufacturing Methodologies

Based on previous work carried out by Chandraprakaikul (2008) and Lim (2007), a few potential methodologies from the category of manufacturing strategy have been selected for further evaluation. Similar to the criteria used in selecting the PSS methodologies, all these methodologies have a Step-by-Step structure. The selected potential methodologies are:

- Chandraprakaikul (2008)- Global Supply Chain Positioning for Manufacturer
- Lim (2007)- Supply Chain Strategic Positioning Strategy Formulation for Singapore SMEs
- The Manufacturing Foundation et al. (2006)- Off-shoring
- Baines et al. (2005)- Manufacturing Strategic Positioning Formulation
- Tan & Platts (2005)- Effective Strategic Action Planning

- Adesola (2002) - Methodology for Business Process Improvement - MIPIM
- Probert et al. (2000) - Technology Management and Assessment

The comparison of the selected potential manufacturing methodologies against the requirements set for the PSSE methodology is shown in Table 17.

Similar to the comparison process for the category of PSS methodologies, the selected methodologies were first evaluated against the characteristics set for a good methodology, which were; Scope and Objectives, Step-by-Step Structure, Tools and techniques, Platform for Participation, Project Management, Template for Documentation and Expected Deliverables.

Scope and Objectives - As most of the manufacturing methodologies are not related to or developed for PSS, none of them scored any marks in this category.

Step-by-Step Structure – All methodologies scored a full mark of "2" due to the fact that they all provide a step-by-step structure.

Tools and Techniques – Both Lim (2007) and Baines et al. (2005) have been given a full score of "2" in this category due to the fact that they have provided very detailed description of the tools and techniques used in their methodology. The rest of the methodologies have been given a partially fulfilled mark of "1" in this category.

Platform for Participation – Chandraprakaikul (2008), Lim (2007), Baines et al. (2005) and Adesola (2002) produced evidence to demonstrate that their methodologies provided a platform for participation, therefore a full

score of "2" was given. The rest of the methodologies were given a partially fulfilled score of "1" due to lack of information.

Project Management – The methodologies of Lim (2007), Baines et al. (2005) and Adesola (2002) were designed to allow effective project management; therefore a full score of "2" was given. The rest of the methodologies did not provide data in this aspect therefore a "0" was given.

Template for Documentation – Again, Chandraprakaikul (2008), Lim (2007), Baines et al. (2005) and Adesola (2002) provided detailed templates for documentation in their methodology, as a result, they were given a full score of "2" in this category.

Expected Deliverables – Except for Tan & Platts (2005) and Probert et al. (2000) who did not have enough information to justify that their methodologies have delivered the expected deliverables, most of the methodologies have presented strong evidence by using case studies to demonstrate that they have delivered the expected outcomes. Therefore, except for Tan & Platts (2005) and Probert et al. (2000), all methodologies were given a full score of "2".

As shown in Table 17, Lim (2007) and Baines et al. (2005) have the highest score of "12" in fulfilling the requirements set of being a good methodology. In meeting the requirements set of being a practical methodology, all the methodologies were being evaluated using the characteristics set of a practical methodology namely, Feasibility, Usability and Usefulness.

Table 17: Comparison of Existing Manufacturing Methodologies against the Requirements Set for f PSSE Methodology

Author	Chandrapraka ikul (2008)	Lim (2007)	The Manufacturing Foundation et al. (2006)	Baines et al. (2005)	Tan & Platts (2005)	Adesola (2002)	Probert et al. (2000)
Characteristics Set of the Structure for a Good Methodology 2 - fulfil exactly, 1 – fulfil partially or can be used with modification, 0 - data not available							
Scope and objectives	0	0	0	0	0	0	0
Step-by-Step Structure	2	2	2	2	2	2	2
Tools and Techniques	1	2	1	2	1	1	1
Platform for Participation	2	2	1	2	0	2	1
Project Management	1	2	0	2	0	2	0
Template for Documentation	2	2	1	2	0	2	0
Expected Deliverables	2	2	2	2	0	2	1
Score (max 14)	**10**	**12**	**7**	**12**	**3**	**11**	**5**
Characteristics Set of the Applicability for a Good Methodology 2 - fulfil exactly, 1 – demonstrated with case study, 0 - data not available							

Feasibility	2	2	0	2	0	2	0
Usability	2	2	0	2	0	2	0
Usefulness	2	2	0	2	0	2	0
Score (max 6)	**6**	**6**	**0**	**6**	**0**	**6**	**0**
Activities of the PSSE Methodology 2 - fulfil exactly, 1 – fulfil partially or can be used with modification, 0 - data not available							
PSS Competitiveness Analysis	0	0	0	0	0	0	0
PSS Activities Design	0	0	0	0	0	0	0
Score (max 4)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Content and Delivery Mechanism Preferred by Singapore Industry 2 - fulfil exactly, 1 – can be used with modification, 0 - data not available							
Understand Customer Needs and Acceptance	1	0	0	0	0	0	0
Assess Critical Success Factors	1	2	0	2	0	0	0
Facilitated Workshop	1	2	0	2	0	2	0
Score (max 6)	**3**	**4**	**0**	**4**	**0**	**2**	**0**
Final Rating Score (max 30)	**19**	**22**	**7**	**22**	**3**	**19**	**5**

Feasibility, Usability and Usefulness - In meeting the requirements for a practical methodology, Chandraprakaikul (2008), Lim (2007), Baines et al. (2005) and Adesola (2002) all scored a full mark of "2" in all characteristics in this category. This was due to the fact that these methodologies have been evaluated using this set of characteristics as guideline in actual industrial applications. For example, Chandraprakaikul (2008) has tested the global supply chain positioning methodology by using more than 10 case studies from UK industry and methodology by Lim (2007) has tested using more than 5 case studies from Singapore industry. As for rest of the methodologies, as no evidence or data was presented, no mark was given.

PSS Competitiveness Analysis – No mark was given in this category as all the manufacturing methodologies did not provide PSS competitiveness analysis. **PSS Design Activities** – No mark was given in this category as all the manufacturing methodologies did not provide PSS design activities.

Understand Customer Needs and Acceptance – Except for Chandraprakaikul (2008), no mark were given in this category as none of the other methodologies include understanding of customer needs and acceptance in their methodologies.

Assess Critical Success Factors – Apart from Chandraprakaikul (2008), Lim (2007) and Baines et al. (2005) who were given a full mark of "2", no mark were given to the rest of the methodologies as they did not include activities to asses critical success factor.

Facilitated Workshop - Lim (2007), Baines et al. (2005) and Adesola (2002) were given a full score of "2" in this category due to the fact that their methodologies were specifically designed for facilitated workshops. Chandraprakaikul (2008) has been given a partialyl fulfilled score of "1" as the structure of the methodology appeared to be too complex to be

used effectively in a facilitated workshop. No mark was given to the rest of the methodologies as no evidence was given.

In summary, both Lim (2007) and Baines et al. (2005) have emerged as the top two potential manufacturing methodologies with a total score of 22, followed by Chandraprakaikul (2008) and Adesola (2002) with a score of 19 respectively.

6.5. SELECTION OF FINAL POTENTIAL METHODOLOGIES

The comparison of the existing methodologies against the set requirements has shown that there are no existing methodologies from both the category of PSS and manufacturing methodology scored the full marks of 30 and thus none have fully satisfied all of the requirements of the new PSSE methodology outlined in Table 11 of Chapter 5. However, the methodologies that scored higher than 20 points can generally be considered as good potential methodologies as have they basically demonstrated that they fulfil most of the requirements set for the PSSE methodology.

From the analysis of the results in Sections 6.4.1 and 6.4.2, the following methodologies emerged as the top highest methodologies with a score above 20:

- MEPSS (2004) - Methodology for PSS Design
- Lim (2007) - Supply Chain Strategic Positioning Strategy Formulation for Singapore SMEs
- Baines et al. (2005)- Manufacturing Strategic Positioning Formulation

All the top three methodologies generally posses most of the set characteristics required for a good and practical methodology. The

methodologies are captured in the form of a workbook and the MEPSS toolkit has been made available on the web.

Of the three potential methodologies, MEPSS is the only methodology that contains PSS design activities. It is the first pilot PSS methodology that was developed to design, develop, implement and monitor PSS. It focuses on aspects such as determination of successes and failures of a PSS in terms of customer acceptance and cultural aspect and helps to assess and evaluate the lifecycle and macro effects of PSS in environmental, economic, and social sustainability terms. However, MEPSS did not include any manufacturing content, or provide evaluation in the changes of manufacturing capabilities policies affected by the introduction of a new PSS strategy.

The other two potential methodologies, namely Lim (2007) and Baines et al. (2005) were developed to assist the strategic positioning and supply chain management for the manufacturer. Although these two methodologies did not cover PSS design activities, they have been specifically developed for the manufacturing industry as well as demonstrating the strengths in fulfilling most of the requirements set for being a good and practical methodology. Amongst all three potential methodologies, Lim (2007) is the only manufacturing methodology that has been tailored to the Singapore manufacturing industry.

All three methodologies, namely MEPSS (2004), Lim (2007), and Baines et al. (2005) thus will therefore be selected to form the methodological base for the new methodology, as they all have demonstrated strengths in fulfilling most of the requirements set of the new PSSE methodology. The detailed description of the stages of the three methodologies is shown in Tables 18, 19 and 20.

6.6. CHAPTER SUMMARY

This chapter provided a detailed discussion of the evaluation of the existing PSS and manufacturing methodologies against the set requirements as outlined in Chapter 5. It discussed the objective and method of the evaluation process and analyses the existing methodologies against the set requirements. In summary, none of the methodologies reviewed fully satisfy the requirements set of the new PSSE methodology. Hence, in the next Chapter, the process of selecting the most appropriate and suitable components from the three selected methodologies to form the conceptual base of the PSSE methodology will be discussed.

Table 18: Methodology Structure of Lim (2007)

Process	Steps	Output
1. Scope Issues		Issue statement specifying overriding problems
2. Identify Activities and Resource Landscape	2.1. Identify initial activity map 2.2. Identify initial resource map	Initial activity and resource landscape map of the company
3. Identify Significant Activities and Critical Resources	3.1. Identify significant activities 3.2. Identify critical resources	Summary of significant activities and critical resources
4. Review Competitive Strategy	4.1. Identify current and desired competitive strategy 4.2. Analyse competitive gaps	Current competitive strategy and the competitive gap analysis
5. Alignment Check Between Performance and Strategy	5.1. Alignment of significant activities and critical resources and strategy 5.2. Alignment of competitive gap and strategy	Alignment check of significant activities, critical resources and strategy; and gap and strategy
6. Formulate Strategy	6.1. Propose action for significant activities 6.2. Propose actions for critical resources 6.3. Summary of proposed actions	Summary of proposed action

Table 19: Methodology Structure of Baines et al. (2005)

Process	Steps	Output
1. Scope Issues	1.1. Select products and services with shared competitive strategy 1.2. Competitive strategy review 1.3. Competitive gap analysis 1.4. Alignment check between performance and strategy 1.5. Generate issue statement	Qualified Issues Statement
2. Identify Key Decision Criteria	2.1. Selection of FACTS criteria 2.2. Determine weighing of FACTS criteria 2.3.Consistency check	Key Decision Criteria
3. Identify Activities Landscape	3.1. Form initial activity map 3.2. map emergent, mature and declining activities 3.3. Identify significant activities 3.4. Identify related activities	Significant Activities and Related Activities
4. Assess Impact	4.1. Condition analysis 4.2. Action analysis 4.3. Gross significant activities impact analysis 4.4. Gross related activities impact analysis 4.5. Net impact and ranking analysis	Ranked Activities Identified for Change
5. Consolidate Outcomes	5.1. Check and record issues statement 5.2. Check and record key decision criteria 5.3. Check and record significant activities and proposed actions 5.4. Check and record related activities, impact form and net impact score 5.5. Allocate future actions, responsibilities and timescale	Project Summary

Table 20: Methodology Structure of MEPSS (2004)

1. Strategy Analysis	1.1 Preparatory Phase	1. Getting prepared 2. Management meeting 3. Project planning
	1.2 Stakeholder Identification	1. Definition of stakeholders 2. Prioritisation of stakeholders and involvement planning
	1.3 Evaluation Strategy	1. Discussion of visions 2. Definition of assessment strategy
	1.4 System Analysis Workshop	1. Workshop preparation 2. System analysis workshop Definition of variables, cross impact analysis, system behaviour, value system map
	1.5 Elaboration of Results	1. System analysis results 2. Preparation of decision
2: Exploring Opportunities	2.1 Preparing Scenario Workshop	1. Stakeholders' involvement Planning 2. Update Sustainability aspects 3. Explore Customers' needs 4. Strategic Options for Scenarios 5. Prioritize Sustainability Guidelines
	2.2 Performing Scenario Workshop	1. Building PSS Scenarios
	2.3 Elaboration of Results	1. Elaborate scenarios' format 2. Scenario Preliminary Sustainability Assessment 3. Visualise Sustainability aspects of PSS scenario.
3. PSS Idea Development	3.1 Preparatory Phase	1. Prioritise sustainability guidelines
	3.2 PSS Idea Design	1. Idea development 2. Stakeholders' input generation
	3.3 Elaboration of Results	1. PSS Idea Sustainability assessment 2. Visualise Sustainability aspects of PSS idea 3. Selection of best PSS version.
4. PSS Concept Design	4.1 Preparation	1. Attuning to Customer Preferences 2. Stakeholders' Input Integration
	4.2 PSS Design	1. PSS dimensions design 2. Customising to target groups
	4.3 Elaboration of Results	1. PSS Specifications 2. PSS Sustainability Evaluation 3. Visualise Sustainability aspects of developed PSS
5. Development & Implementation of PSS Project	Technology commercialization Option	1. Commercialization Models for Venture, Small Business and Big Business

CHAPTER 7: FORMATION OF THE PILOT PSSE METHODOLOGY

Chapter 6 discussed the process of selecting the potential methodologies against the set requirements for the PSSE methodology. This chapter deals with phase 3 of the research programme, which is the development of a pilot PSSE methodology.

This chapter first presents the objective and research method of this phase in Section 7.1. The structure of the pilot PSSE methodology is then determined in Section 7.2 and the content of the PSSE methodology together with the framework of a competitive PSS strategy is presented in Section 7.3. Section 7.4 discusses the new tools developed for the measurement of the competitiveness of PSS elements and Servitizability of a company. Section 7.5 describes the delivery mechanism of the methodology. Finally, an overview of the pilot PSSE methodology is described in Section 7.6 followed by a chapter summary in Section 7.7.

7.1. PHASE 3: OBJECTIVE AND RESEARCH METHOD

The objective of phase 3 of the research programme is to develop a step-by-step structural PSSE methodology. Chapter 4 explained the rationale behind the process of forming the PSSE methodology. It was proposed in Section 4.4.3 that the structure of the methodology should be developed based on the existing potential methodologies together with the opinions and data gathered from the Singapore industry concerning its content and delivery mechanism.

Chapter 5 presented the results of the case studies conducted in the Singapore Manufacturing Industry concerning the preferred content and delivery mechanism of the PSSE methodology. It has also established the requirements set for the PSSE methodology. Chapter 6 described the selection process of the potential methodologies. As presented in Chapter 6, none of the existing methodologies completely fulfilled the requirements set, thus it is not feasible to adopt any of the existing methodologies as references. Consequently, the proposed research method is to adapt the best process or steps from the existing methodologies to form the conceptual base of the new PSSE methodology.

One methodology from the category of PSS strategy and two from the category of manufacturing strategy have been selected. These include Methodology for Product Service System (MEPSS (2004), Supply Chain Strategic Positioning Strategy Formulation for Singapore SMEs Lim (2007), and Manufacturing Strategic Positioning Formulation Baines et al. (2005).

Section 4.4.3 has established that the development process of the formation of the new PSSE methodology is to first determine the structure and then the content, followed by the delivery mechanism of the methodology. New tools will be developed where necessary. The research method used in determining the structure of the methodology is to select the most appropriate stages from the three selected methodologies using one of the most commonly used strategic decision models available in the literature as a guideline. The content can be defined by studying the elements described in each of the stages of the selected methodology against the requirements set for the PSSE methodology. An overview of phase 3 of the research programme is illustrated in Figure 19.

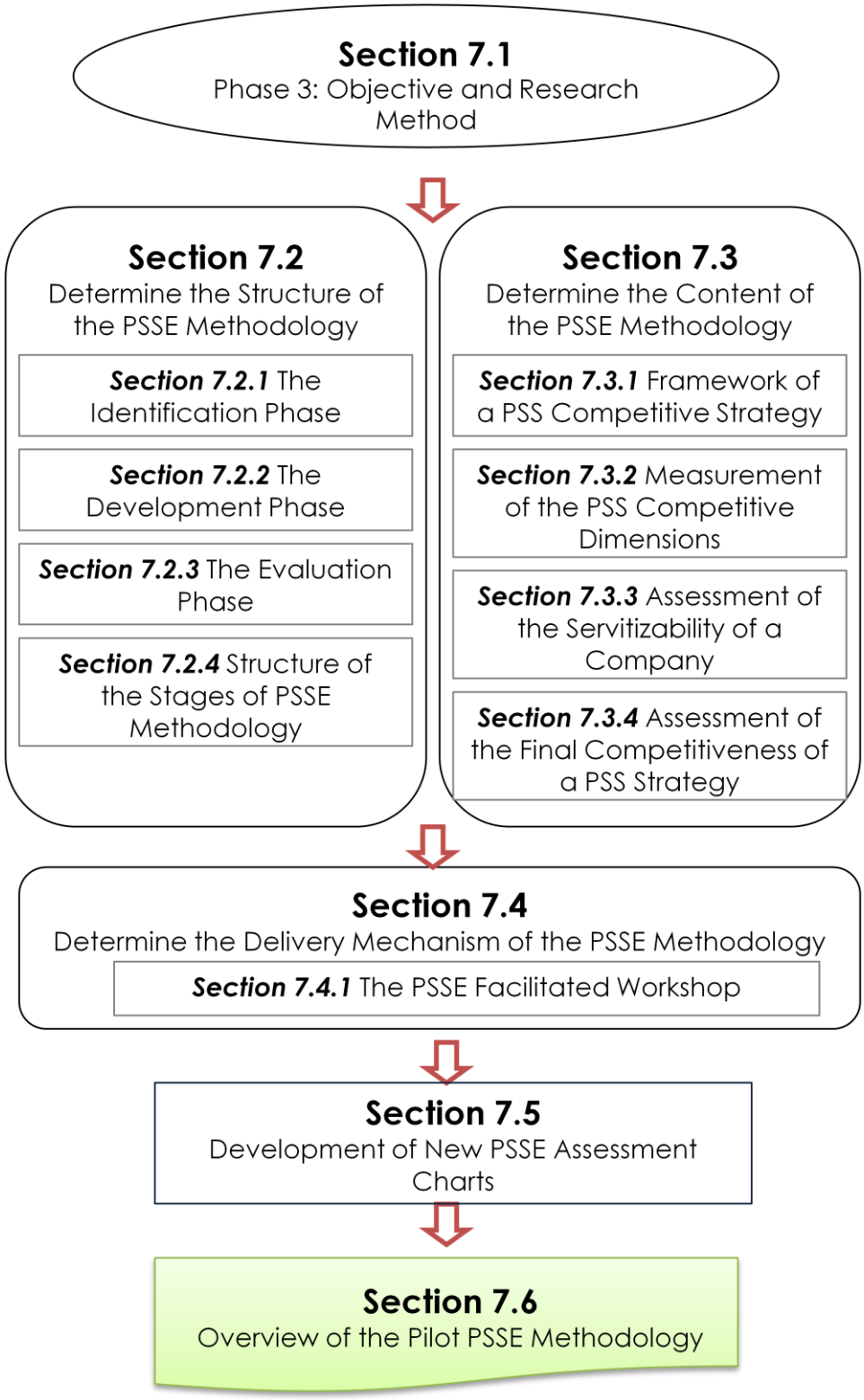


Figure 19: Overview of the Structure of Phase 3 of the Research Programme

7.2. DETERMINATION OF THE STRUCTURE OF THE PSSE METHODOLOGY

This section sets out to establish the structure of the PSSE methodology. It describes the research process used to determine the basic structure of the pilot PSSE methodology. The structure of the PSSE methodology will be developed based on the identification and extraction of the suitable and useful processes from the three selected methodologies described in Section 6.6.

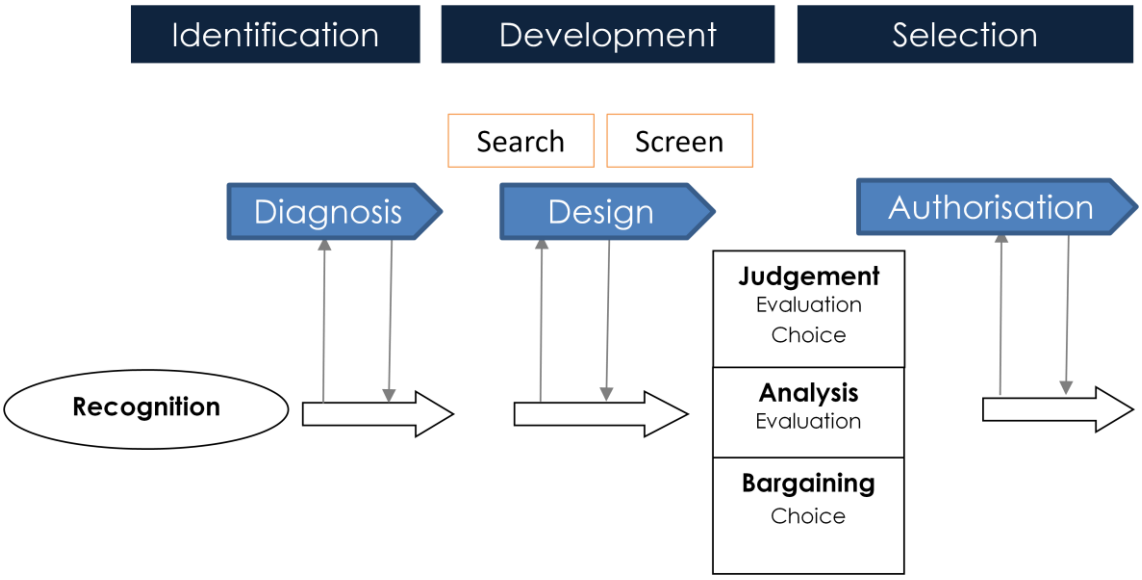


Figure 20: A General Decision Making Process Model.

Adopted from Mintzberg et al. (1976)

As illustrated in Figure 20, Mintzberg et al. (1976) propose a three-phase decision making model. These three phases are identification, development and selection. This decision model has been adopted by researchers such as Lim (2007) and Chandraprakaikul (2008) in the development of their manufacturing decision making strategies. Thus it will be used as a guide to illustrate how the suitable steps in the three selected methodologies can be chosen to form the basic structure of

the pilot PSSE methodology. The process of mapping the selected methodologies to the three-phase decision making model is illustrated in Table 21.

7.2.1 *The Identification Phase*

As shown in Figure 20, the identification phase consists of two major processes: Recognition and Diagnosis. The objective of this phase is to recognise a problem situation and to provide a tentative diagnosis for it. A decision making process usually starts when there is a discrepancy between the actual and desired situation, or when the desired situation is a completely new situation with no existing solution or data available to validate it.

As shown in Table 21, all the three selected methodologies started with scoping and analysing issues in this phase. MEPSS (2004) starts with strategy analysis and identification of opportunities and problems, whereas both Lim (2007) and Baines et al. (2005) begin with scoping the issues relating to overriding problems of the company; areas to be analysed and challenges to be tackled.

In the case of the PSSE methodology, the decision process starts when the companies realise that the competitive edge created by the traditional product oriented business model in the past is losing its ground. The diagnosis or solution to tackle such a problem is to go for Servitization. The action items provided by the three selected methodologies in this stage are quite relevant to the objective of the PSSE methodology and as a result the proposed action in this phase of the methodology is to combine them.

The proposed structure of the identification phase of the PSSE methodology is shown below.

Proposed structure of the identification phase of the PSSE Methodology:

Stage 1
1.1. Identify Reasons for Servitization and Overriding Challenges
1.2 Exploring Opportunities - identify product range for Servitization
1.3 Forming Servitization Task Force

7.2.2 The Development Phase

The development phase consists of two processes, namely, Search and Design. "Search" refers to the exploration of existing solutions and "Design" refers to the designing of new solutions. As shown in Table 21, for the "Search" process, both Lim (2008) and Baines et al. (2005) propose action items in this phase to identify the activity landscape of the company. Lim (2008) has further expanded the process to identify critical resources which are important in supporting the SMEs when they embark on new activities. As for the "Design" process, MEPSS (2004) has proposed a process to design PSS idea and develop concepts in this phase.

It seems logical to include all the processes from the three selected methodologies in this phase. As a result, the proposed structure of the development phase of the pilot PSSE methodology is as follows:

Proposed steps of the development phase of the pilot PSSE Methodology:

Stage 2:
2.1. Identify Driver, Barriers and Service Activities

Stage 3
3.1 PSS Idea & Concept Development
3.2 Identify Resource to Support PSS Activities

Table 21: Mapping the Selected Methodologies against the Proposed Methodology Phases

Generic Model	IDENTIFICATION		DEVELOPMENT		SELECTION		
	Decision Recognition	**Business Diagnosis**	**Search**	**Design**	**Screen**	**Evaluation**	**Authorisation**
Lim, (2007)	1. Scope issues		**2. Identify activity and resource landscape**		3. Identify significant activities and critical resources **4. Review competitive strategy**	5. Alignment check between performance and strategy	6. Formulate strategy
Baines et al. (2005)	**1.Scope issue**		3. Identify activity landscape		**2. Identify key decision criteria**	**4. Assess impact**	**5. Consolidate Outcome**
MEPSS (2004)	1. Strategy analysis	**2. Exploring opportunities**		**3. PSS Idea development 4. PSS concept design**	5. Development and implementation of PSS project		
	⇩		⇩	⇩	⇩	⇩	⇩
Decision Making Process	**IDENTIFICATION**		**DEVELOPMENT**		**EVALUATION**		
	Decision Recognition	Business Diagnosis	Search	Design	Screen	Evaluation	Authorisation
Useful Stages that can be used in the Pilot PSSE Methodology	Step 1 : 1.1 Scope Issue 1.2 Exploring Opportunities		Step 2: 2.1. Identify Activity Landscape 2.2. Identify Resource Landscape	Step 3: 3.1 PSS Idea Development 3.2. PSS Concept Design	Step 4: 4.1. Identify Key Decision Criteria 4.2 Review Competitive Strategy	Step 5: 5.1 Assess impact	Step 6: 6.1. Consolidate Outcome 6.2. Development and Implementation of PSS Project

7.2.3 The Evaluation Phase

The last phase of the decision making process is the selection phase. This is one of the most important phases of the PSSE methodology as its objective is to evaluate the competitiveness of a new PSS strategy. As shown in Figure 19, the three main activities in the selection phase are "Screen", "Evaluation" and "Authorisation". As the objective of the PSSE methodology is mainly to evaluate whether the new PSS is a competitive strategy, this phase has been renamed the Evaluation phase.

Table 21 shows that a few processes from the selected methodologies can be useful in this phase. For example, in terms of the "Screen" process, the "Identify Key Decision Criteria" process by Baines et al. (2005) and the "Review Competitive Strategy" process by Lim (2007) can be useful. For the "Evaluation" process, none of the processes from the selected methodologies are relevant because the objective of the PSSE methodology is to perform an evaluation of the competitiveness of the PSS strategy. To determine whether a new PSS is a competitive strategy, the following two dimensions need to be evaluated:

- The competitiveness of the elements of the new PSS strategy
- Servitizability - The ability of the company to deliver the new PSS strategy

As a result, instead of adopting the existing processes from the selected methodologies, new processes such as "Assess the Competitiveness of the PSS Elements" and "Assess the Servitizability of the Company" will be added. The detailed descriptions of the content of the process used to determine the PSS competitive dimensions and elements are presented in Sections 7.3. A detailed description of the content of the process used to define the term "Servitizability" and its assessment criteria is presented in Section 7.3.3. Two new tools, "PSS Competitive Elements Measurement

Chart (PSS-CMC)" and "PSS Servitizability Assessment Chart (PSS-SMC)" will also be designed for the new processes. A detailed discussion of the development of the new tools is presented in Sections 7.5.1 and 7.5.2

The final process of the evaluation phase in the PSSE methodology is to present whether the new PSS strategy under assessment is a good competitive strategy. Therefore, the "Consolidate Outcome" process from Baines et al. (2005) can be adopted. However, as the purpose of the PSSE methodology is to present the report card upon the competitiveness of the new PSS strategy, it is proposed that another new process entitled "Generate PSS Competitiveness Score Card" should be developed in this phase. In order to present the result of the score card in this new process, a new tool, entitled "PSS Competitiveness Assessment Matrix (PSS-CAM)" is developed and its detailed description is presented in Section 7.5.3.

In summary, the proposed structure of the evaluation phase of the pilot PSSE methodology is as follows:

Proposed structure of the evaluation phase of the PSSE Methodology:

Stage 4:
4.1. Identify Key Decision Criteria
4.2. Review Competitive Strategy

Stage 5:
5.1. Assess Competitiveness of PSS Elements (new)
5.2 Assess Servitizability of Company (new)

Stage 6:
6.1. Consolidate Outcome
6.2. Generate PSS Competitiveness Score Card (new)

7.2.4 Structure of the Stages of PSSE Methodology

The structure of the stages of the PSSE methodology is illustrated in Figure 20. It is designed based on the requirements of the set characteristics for a good PSSE methodology as outlined in Table 11:

- Aim – it must have a purpose
- Action – it must describe the steps to carry out each stage in order to achieve the aim of the stage
- Participation – it must provide platform and means for interaction and discussion
- Expected Deliverables – it must describes the expected outcomes of each stage
- Tools and Techniques – it must provide feasible, usable and useful tools in each stage
- Project Management – it should allocate time and resources required for the actions in each step

This section discusses the structure of the overall PSSE methodology and its stages. In the next section, the determination of the content of the PSSE methodology will be discussed.

7.3. DETERMINATION OF THE CONTENT OF THE PSSE METHODOLOGY

This section discusses the content of the PSSE methodology. The main purpose of the methodology aims to provide a systematic and structural approach for assessing whether the move towards adopting a new PSS is a competitive strategy. As discussed in Section 7.2, apart from adopting some of the relevant processes from the three selected methodologies, the following new processes need to be designed to deliver the objective of the PSSE methodology:

- Assess the Competitiveness of the PSS Elements
- Assess the Servitizability of the Company
- Assess the frinal Competitiveness of a new PSS Strategy

In order to determine the processes of the above mentioned assessments, a framework of a PSS competitive strategy has to be developed.

7.3.1 Framework of a PSS Competitive Strategy

A good PSS competitive strategy will offer a manufacturer the competitiveness to compete in the market. As discussed in Chapter 3, competitiveness is the ability to get customers to choose your products or services over competing alternatives on a sustainable basis (Schlie, 1995). Competitive strategy is a concept that is perhaps the most closely associated with Porter (1980), who describes it as:

"essentially, developing a competitive strategy is developing a broad formula for how a business is going to compete, what its goal should be, and what policies will be needed to carry out those goals" – Porter, 1980

As a competitive strategy, the value proposition of a PSS is inarguably to create competitiveness for a company. Since the goal of a PSS is to deliver value in use via an integrated combination of product and service, it can also been seen as offering the Best Packaged Solution to the customers. Therefore, another competitive strategic concept that can be used to describe PSS strategy is the "Best Packaged Offering" concept as proposed by Baines (Baines, 2009). Baines proposes a competitive strategy concept based on the Best Packaged Offering (Offering the best total solution to the customers), Best Price Offering (Offering the best total cost to the customers) and Best Product Offering (Offering the best product to the customers).

In the context of manufacturing strategy, the other widely used competitive strategy concept is the value preposition model proposed by Treacy and Wiersema (Treacy and Wiersema, 1993), who relate competitive strategy to Customer Intimacy, operational excellence and product leadership. As the purpose of a PSS competitive strategy is to satisfy the customer's needs, in the long term, it can be seen as a strategy focusing on establishing long term, customer relationships, providing the best customer experience and ultimately developing Customer Intimacy.

Porter (1980) proposes three generic strategy choices, namely, Differentiation, cost leadership and focus, for his competitive strategy model. As discussed, a PSS strategy can be seen as competing based on "Best Packaged Offering" (Baines, 2009), and "Customer Intimacy" (Treacy and Wiersema, 1993). Using Porter's competitive model, a PSS strategy can also be viewed as competing if based on creating the competitive dimension of "Differentiation", because it allows the development of the Best Packaged Solutions to fulfil customers' needs and developing Customer Intimacy.

Table 22: Summary of Concepts Relating to Competitive Strategy

Competitiveness	*Competitiveness is the ability to get customers to choose your products or services over competing alternatives on a sustainable basis - Schlie(1995)*	
Strategy	*The determination of basic long term goals and objectives of an enterprise, and the adoption of courses of actions and the allocation of resources necessary for carrying out these goals. – Chandler(1962)*	
Competitive Strategy	*A broad formula for how a business is going to compete, what its goal should be, and what policies will be needed to carry out those goals Porter(1980)*	
Competitive Strategic Choice (Elements)	Porter (1980)	Cost Leadership, Differentiation, Focus
	Baines (2009)	*Best Packaged Offering, Best Price Offering, Best Product Offering*
	Treacy & Wiersema (1993)	*Customer Intimacy, Operational Excellence, Product Leadership*

To conclude the discussion above, the proposed competitive dimensions of a PSS competitive strategy can be generated by combining the relevant competitive choices of Porter (1989), Baines (2009) and Treacy and Wiersema (1993). Figure 21 shows the proposed framework of a PSS competitive strategy and it consists of the following competitive dimensions:

- **Best Packaged Solution**: Firstly, a PSS competitive strategy offers the Best Packaged Solution, focusing on delivering total solutions in a combined package of product and service to the customer
- **Customer Intimacy**: Secondly, it emphasises delivering value in use, which focuses on establishing the long term customer relationships, providing the best

customer experience and developing Customer Intimacy

- **Differentiation**: Thirdly, it creates a distinct Differentiation and value preposition through the offering of the Best Packaged Solution and Customer Intimacy

Section 7.3.1 discussed the development of the PSS competitive dimensions. In the next section, the competitive elements of the PSS competitive strategy and its performance criteria will be discussed.

7.3.2 Measurement of the PSS Competitive Dimensions

This section discusses the content required by the process "Assess the Competitiveness of PSS Elements".

Competitive Elements of Best Package Solution

Adam and Swamidass (1989) point out that the real test of a manufacturing strategy is its effect on operations and overall performance. Therefore, it is important to determine the competitive elements that are likely to affect the overall performance of a PSS strategy in order to determine its competitiveness. For example, a delay in product or service delivery could be due to a manufacturing resource being heavily utilised or a technical fault in the production line.

Platts and Gregory (1990) believe that manufacturing strategy is formed to achieve business goals and these goals are predominantly defined in terms of competitive priorities, for example, quality, cost and time (Platts and Gregory, 1990). Thus, all these elements can be used to measure the performance of the dimension of *Best Packaged Solution* of the PSS strategy.

In the area of measuring services, Olouuniwo (2008), who has cited Schmenner (1986), propose to use elements like *Tangible Quality* (product performance), *Responsiveness* (speed in getting back to the customer), *Recovery* (speed in correcting faults), *Knowledge* (Product + Service Knowhow), *Accessibility, Flexibility and Reliability* (Olorunniwo et al., 2006).

Thus, the following set of competitive elements will be proposed to measure the performance of the competitive dimension of *Best Packaged Solution* of a PSS strategy.

- ***Quality*** - Measured by using variables such as quality of the product and services provided, product capability in delivering the promised functionality and product conformance to the specification
- ***Cost*** - Determined by the cost of the entire PSS life cycle operation
- ***Flexibility*** – Measured by the flexibility in product customization, service customization, variety of services and service contract
- ***Delivery*** – Determined by the responsiveness in delivering the new PSS
- ***Innovativeness*** – Determined by the unique selling features of the new PSS

Competitive Elements of Customer Intimacy

Measuring inputs and outputs of the tangible physical products is relatively easy compared to the measurement of the intangible output of the service offering. Service quality is perceived and experienced, and relies heavily on the quality of the service delivery personnel (Olorunniwo et al., 2006). In services, the customer will pay only what

they think the service is worth. Although some quantitative measurement could be straight forward, (e.g. number of service units delivered, customer retention, size of customer base, number of training sessions conducted) the quality of a value delivered and Customer Intimacy level can only be measured by using subjective criteria such as customer satisfaction and customer experience (Kumar & Markset, 2007; Panizzolo, 2008). Chase (1991) presents a set of guidelines for measuring service value chain performance while concluding with several propositions linking internal and external customers' satisfaction with factory services (i.e. information, problem solving, sales and support).

As a result, in this research, the following two competitive elements will be used to measure the performance of the competitive dimension of *Customer Intimacy* of a PS strategy:

- ***Customer Loyalty*** - Measured by using the number of return customers
- ***Customer Satisfaction*** - Measured using variables such as acceptance and willingness to pay

Competitive Elements of Differentiation

The success of a PSS strategy will ultimately be measured by its financial and marketing performance. Thus, traditional elements that are used to measure the business performance of a company shall be used to measure the performance of the dimension of *Differentiation* of a PSS strategy:

- ***Financial Performance*** - Measured using variables such as cash flow, turnover, profit and return of investment

- ***Marketing Performance*** - Measured using variables such as market share, market penetration and brand reputation

Table 23 summarises the list of competitive elements and performance criteria used to measure the competitive dimensions of a PSS strategy. The framework of a PSS Competitive strategy with its competitive dimensions and elements is illustrated in the Figure below.

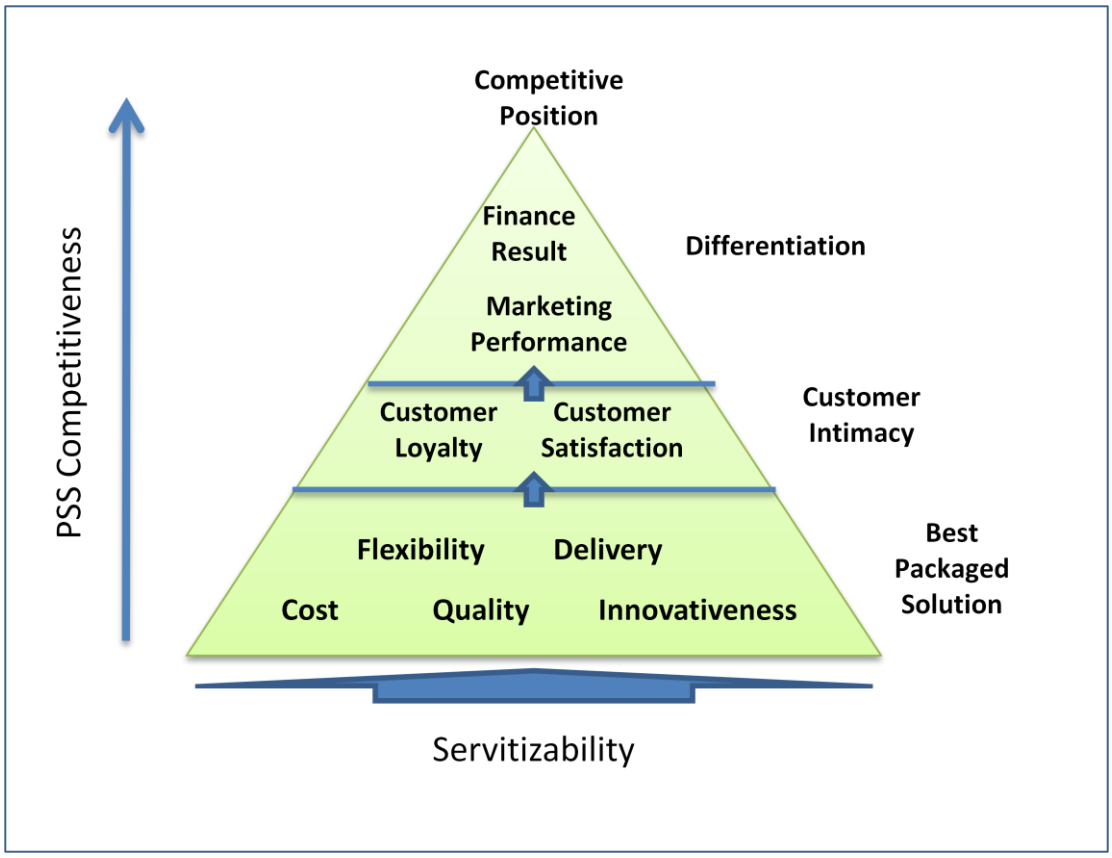


Figure 21: Framework of a PSS Competitive Strategy

Table 23: Performance Criteria of the PSS Competitive Dimensions

Competitive Dimensions	Competitive Elements	Performance Criteria
Best Packaged Solution	*Cost*	*Product Life cycle Cost , Service Cost*
	Quality	*Conformance to Specification Reliability*
	Delivery	*Responsiveness, Service Recovery, Product Availability*
	Flexibility	*Accessibility, Level of Product Customisation, Variety of Services -SSP, SSC*
	Innovativeness	*New Feature of Product and Service*
Customer Intimacy	*Customer Satisfaction*	*Acceptance, Willingness to Pay*
	Customer Loyalty	*Base (number of returned customer)*
Differentiation	*Competitive Positioning*	*Target market segments (competitive advantage)*
	Financial Performance	Cash flow, Turnover, Profit and Return of Investment
	Marketing Performance	*Market share, Market penetration, Brand Reputation*

7.3.3 Assessment of the Servitizability of a Company

Section 7.3.2 discussed the performance criteria required to measure the competitiveness of the PSS elements. In this section, the performance criteria required for measuring the Servitizability of a Company will be discussed.

An organisation capability in transforming itself to support the new service oriented business and manufacturing plays a vital role in maintaining the competitiveness of the new PSS strategy. Skinner (1969) points out that a firm's competitive strategy drives its manufacturing strategy, leading to operational decisions which have resulted in the desired performance (Chandler, 1962). Baines et al. (2008) propose a framework that captures a set of operations principles, structures and

processes that can be used to guide a manufacturer in the delivery of product-centric servitized offerings.

The ability to support the new PSS strategy, both structurally and infra-structurally, has been termed as "Servitizability" in this research. Thus, to measure the Servitizability, the set of criteria described in the framework for product-centric servitized offering proposed by Baines et al. (2008) will be adopted to evaluate the Servitizability of a company. This set of criteria is divided into two categories, namely, "Structural" and "Intra-structural":

Structural:

- ***Process and Technology*** - The transformation processes and technologies, and most critically the way in which they are organised in order to deliver PSS
- ***Capacity*** - The maximum output of the factory
- ***Facilities*** - The factory 'size and location; and its focus in delivering PSS
- ***Supply Chain Positioning*** - Supply chain design to deliver PSS
- ***Planning and Control*** - Planning and control process of service delivery
- ***Span of Process*** - The degree of vertical integration

Infra-Structural:

- ***Human Resources*** - All the people-related factors, including both personal and organisational level
- ***Quality Control*** - The means of ensuring that products, services and people operate to specification to fulfill customer needs

- ***Product/ Service Range*** - Existing products and services to deliver PSS
- ***New Product / Service Introduction*** - New products specifically designed to deliver PSS and features of new services

The set of criteria used to assess the Servitizability of a company is shown in Figure 24.

7.3.4 Assessment of the Final Competitiveness of a PSS Strategy

The three competitive dimensions proposed in Section 7.3.1 for a PSS competitive strategy are the 'Best Packaged Offering', 'Customer Intimacy' and 'Differentiation'. In theory, a competitive PSS strategy focuses in delivering total solutions in a form of a 'Best Packaged Offering' to the customer. It then leads to the establishment of Customer Intimacy and ultimately helps to create the desired preposition of Differentiation. However, in reality, although Customer Intimacy can be generated through the provision of a 'Best Packaged Offering', it does not necessarily result in the creation of Differentiation, if a manufacturer does not possess the ability to deliver the 'Best Packaged Offering' and maintain good Customer Intimacy. As a result, manufacturers need to equip with high level of Servitizability in order to deliver a competitive PSS strategy.

It is thus proposed that, the competitiveness of a PSS strategy will be determined by both the level of competitiveness of its elements and the Servitizability of a company.

Table 24: Criteria for Assessing the Servitizability of a Company

Policy Areas Adopted from Baines et al., 2008

Evaluation of Servitizability		
Policy Area	**Description**	**Evaluating Criteria**
	Structural	
Process and Technology	The transformation processes and technologies, and most critically the way in which they are organised in order to deliver PSS	The ability of the company to achieve efficiency in production and effectiveness in delivering the promised service
Capacity	The maximum output of the factory	The ability of the company to operate with differing levels of capacity utilisation
Facilities	The factory's size and location; and its focus in delivering PSS	The ability of the company to produce and assemble, along with multiple field facilities for maintenance and repair located close to market
Supply Chain Positioning	Supply chain design to deliver PSS	The ability of the company to retain vertical integration in product manufacture and a range of closely integrated partners to deliver services
Planning and Control	Planning and control for the process of service delivery	The ability of the company to focus on the optimisation of service availability and responsiveness
Span of Process	The degree of vertical integration	The ability of the company to develop service oriented processes
	Infrastructural	
Human Resources	All the people-related factors, both personal and organisational levels	The ability of the workers with high levels of product knowledge and relationship development capability
Quality Control	The means of ensuring that products, services and people operate to specification to fulfil customer needs	The ability of the company to ensure that the product and service produced meet the customer satisfaction
Product/ Service Range	Existing products and services to deliver PSS	The ability of the company to produce products to support services
New Product / Service Introduction	New products specifically designed to deliver PSS and features of new services	The ability of the company to produce new product to support services and to produce services that are inimitable

The following four types of PSS Competitive Strategies have been proposed:

- ***STAR PSS Strategy*** -- *High PSS Competitiveness and High Servitizability*

  With a high PSS Competitiveness and high Servitizability, the new PSS strategy will be assessed as a 'STAR Competitive Strategy' for a company. The recommendation to the company is to implement it.

- ***GOOD PSS Strategy*** -- *High PSS Competitiveness and Low Servitizability*

  With a high PSS Competitiveness and low Servitizability, the new PSS strategy will be assessed as a 'GOOD Competitive Strategy' for a company. Although the new PSS strategy has good PSS features, the company does not possess the right capability or policies to deliver it. The recommendation to the company is to improve their service delivery system and capability first before implementing the new PSS strategy.

- ***POTENTIAL PSS Strategy*** - *Low PSS Competitiveness and High Servitizability*

  With a low PSS Competitiveness but high Servitizability, the new PSS strategy will be assessed as a 'POTENTIAL Competitive Strategy' for a company. Although the company has the capability to deliver the new PSS strategy, the weakness of the PSS features and elements, cause it to be classified as a poor competitive strategy. The recommendation to the company is to improve on

the features of the new PSS strategy before implementing it.

- ***WEAK PSS Strategy*** *- Low PSS Competitiveness and Low Servitizability*

  With both low PSS Competitiveness and Servitizability, the new PSS strategy will be assessed as a 'WEAK Competitive Strategy' for a company. The recommendation to the company is to discard the new PSS strategy or to re-design new PSS features and activities, and to continue to build up the company's PSS delivery capability.

7.4. DETERMINE THE DELIVERY MECHANISM OF THE PSSE METHODOLOGY

This section presents the delivery mechanism of the PSSE methodology. As discussed in Section 5.3.5, 80% of the companies interviewed preferred the PSSE methodology to be delivered via a facilitated workshop.

7.4.1 Introduction of the PSSE Facilitated Workshop

A facilitated workshop is normally carried out in the form of a working meeting and intensive sessions. It is usually attended by the management members, stakeholders, key project team members, and/or representatives of the various departments of the company who are likely to be involved in the decision making process(Phillips and Phillips, 1993). It uses multi-criteria decision analysis tools and techniques to discuss the topics of interest and to derive a consensus outcome. Furthermore, brainstorming is another popular technique that is commonly used to solicit inputs from the participants (Miranda and Bostrom, 1997).

One or more facilitators can be used to keep the discussion focused and help to orientate the discussion to avoid sidetracking, and to aid in achieving a mutual understanding amongst the participants. The objectives of a facilitated workshop are to achieve a mutual and common understanding of the issues to be discussed, and to generate a concerted effort and final commitment to the action items to be implemented (Sinkko, 2008).

The PSSE facilitated workshop will be conducted using the new PSSE methodology. A new facilitator's guide will be developed to guide the facilitator in using the PSSE methodology. The purpose of the facilitator's guide is to assist a facilitator in applying the new PSSE methodology in a correct manner and to provide clear step-by-step instructions that are required in conducting the PSSE facilitated workshop. A brief description of the structure of the *PSSE Facilitator's Guide* can be found in Section 9.7.2 and the complete facilitator's guide is presented in Appendix B.

7.5. DEVELOPMENT OF NEW PSSE ASSESSMENT CHARTS

Worksheets and charts are required to clearly present the concept, and to analyse and record the results of each of the stages of the PSSE methodology. Apart from adopting a list of existing worksheets extracted from the three selected methodologies, new worksheets based on the concept of a measurement chart have been developed to assist in delivering the objectives of the PSSE methodology in an effective manner. This section provides the description of two new worksheets that are specifically developed for the new PSSE methodology based on the framework of the PSS competitive strategy developed in this research.

7.5.1 PSS Competitive Elements Measurement Chart (PSS-CMC)

The first new worksheet developed is the PSS Competitive Elements Measurement Chart (PSS-CMC). PSS-CMC was created with the intention to guide the participants in assessing the competitiveness of the elements of a new PSS strategy. Overall scores are generated for a 'Best Packaged Solution', 'Customer Intimacy' and 'Differentiation' which will then be used to compile the overall score of PSS competitiveness.

The design of the PSS-SMC is shown in Table 26. A list of 22 elements has been designed based on the performance criteria generated in Section 7.3.2 for the categories of 'Best Packaged Solution', 'Customer Intimacy' and 'Differentiation'. Each element has a range of -3 to -1 if it is lagging behind the competitor and 1- 3 if it is exceeding the competitor. The overall score will then be used to compile the Competitiveness of the PSS. The maximum score generated from this chart is 66 whereas the minimum score is -66. The dividing point between a low PSS competitiveness and a high competitiveness is calculated as 34 based on the following formula:

Dividing Point of the Level of PSS Competitiveness = 22 (All elements scored a +1 point) + 12 (All elements in the Best Packaged Solutions scored an additional +1 point) = 34

The formula is developed based on the argument that a competitive PSS must be able to perform well in all the three competitive dimensions. As the competitive dimension of 'Best Packaged Solution' forms the core structure of a new PSS strategy, it has given a heavier weightage. As a result, the final scores that will be used to determine the level of PSS Competitiveness are proposed to as follows:

Low PSS Competitiveness = -66 to 34
High PSS Competitiveness = 36 to 66

Table 25: PSS Competitive Elements Measurement Chart (PSS-CMC)

Competitive Elements	Variables	We Lag			We Match	We Exceed			Best Packaged Solution	Customer Intimacy	Differentia -tion
		-3	-2	-1	0	1	2	3			
Cost	PSS Package Price										
	Service / Product										
Quality	Conformance to Specification										
	Reliability										
Flexibility	Variety of Service										
	Service Recovery										
	Product Customisation										
Delivery	Responsiveness										
	Level of Service Customisation										
	Variety of Services										
Innovative-ness	Product Feature										
	Service Feature										
Customer Acceptance	No. of Returned Customer										
Customer Satisfaction	Acceptance										
	Willingness to pay										
Finance Result	Cash flow										
	Turnover										
	Profit										
	Return of Investment										
Marketing Performance	Market share										
	Market penetration										
	Brand Reputation										

7.5.2 PSS Servitizability Measurement Chart: PSS-SMC

The Servitizability Chart allows the facilitator to lead the discussion in assessing the Servitizability of the companies by assessing the various manufacturing policies of the companies with the participants.

A brief outline of the PSS-SMC is shown in Table 26. A list of 25 questions is designed based on the performance criteria in both the structural and infra-structural categories developed in Section 7.3.3 Each question has a range of -3 to -1 for policy areas that the company does not have the capability to deliver a PSS strategy and 1- 3 for policy areas that the company possesses the capability to deliver a new PSS strategy.

The overall compiled score will then be used to assess the Servitizability of the company. The maximum score that can be generated from this chart is 75 whereas the minimum score is -75. The dividing point between a low Servitizability and a high Servitizability is calculated as 37 based on the following formula:

Dividing Point of the Level of Servitizability = 25 (All policy areas scored a +1) + 12 (All policy areas in the Structural category scored an additional +1) = 37

This formula is developed based on the argument that a company needs to possess the capability of achieving an average positive score in most of the policy areas in their new PSS strategy. As a result, the final scores that will be used to determine the level of Servitizability are proposed to as follows:

Low Servitizability = -75 to 35

High Servitizability = 36 to 75

Table 26: PSS Servitizability Measurement Chart: PSS-SMC (Part I)

Manufacturing Policy Areas	Assessment Questions	No			Don't know N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							
	Do you have the right process and technology to produce customised service as required by the new PSS?							
	Does your R&D department have the capability to design product with features to support the new PSS?							
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point" and flexible demands from the customer in terms of special product features and services?							
Facilities - factory size, location etc.	Do you have a service department?							
	Are you able to replace faulty units within the acceptable time required by customer?							
	Is your factory repair unit physical close to the customer's site?							
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?							
	Is your supplier able to support you in the new PSS operation, i.e. product return or part replacement?							
Planning and Control	Are you able guarantee product and service availability to your customer?							
	Is your company recognised as a provider of the best total solution?							

Table 27: PSS Servitizability Measurement Chart: PSS-SMC (Part II)

Manufacturing Policy Areas	Assessment Questions	No			Don't know N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Is your process service-oriented?							
	Do you have a standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide a good service?							
	Do you have the right skilled staff to deliver the promised service?							
Quality Control	Can you deliver services that will meet the customer's specification?							
	Can your product deliver the promised service and functionality?							
Product / Service Range	Do you have a suitable product to support the new PSS?							
	Are you able to provide services exactly as the customer requires/wishes?							
	Do you have the responsiveness to provide a prompt service?							
	Are you able to solve the client's problems and attend to a much broader range of customer's needs?							
	Do you have deep customer knowledge and insights about your customer's underlying process?							
New PSS Introduction	Do you have a finance/billing system to support the new PSS operation?							
	Does your product possess features to monitor the real time usage and health check of the new PSS operation?							
	Are the new services you intend to provide inimitable?							

7.3.5 The PSS Competitiveness Assessment Matrix (PSS-CAM)

As discussed in Section 7.3.4, PSS-CAM has been developed to illustrate the competitive position of a new PSS strategy in the form of a matrix. It will be used in the final stage of the PSSE methodology to determine the final competitive position of a new PSS strategy. As shown in Figure 22, PSS-CAM consists of two axes; the x axis, which represents the competitiveness of the PSS competitive elements and the y axis, which represents the Servitizability of the company:

- ***Axis X – PSS Competitiveness***

  The X axis measures the competitiveness of the PSS in three different aspects, the overall score of the three PSS competitive dimensions, namely, 'Best Packaged Solution, 'Customer Intimacy' and 'Differentiation'. The result was produced by using the PSS-CMC chart in stage 5. As discussed in Section 7.5.1, it divides the level of competitiveness of a new PSS competitive strategy into *Low PSS Competitiveness and High PSS Competitiveness*

- ***Axis Y - Servitizability***

  The Y axis measures the ability of a manufacturer to effectively transform its operations to ensure they support the Servitization strategy, both structurally and infra-structurally**.** The result of the Servitizability was produced by using the PSS-SMC chart in stage 6. As discussed in Section 7.5.2, It divides the level of Servitizability of a company into Low Servitizability and High Servitizability.

The new PSS Competitiveness Assessment Matrix (PSS-CAM) is illustrated in Figure 22.

Figure 22: The PSS Competitiveness Assessment Matrix (PSS-CAM)

7.6. OVERVIEW OF THE PILOT PPSE METHODOLOGY

Based on the processes extracted from the three selected methodology, and the new processes specially designed to assess the competitiveness of a PSS strategy, a 6-stage pilot PSSE methodology has been developed. The PSSE methodology is illustrated in Figure 23 and a brief overview of the stages is described below:

Stage 1: Scope Issues and Exploring Opportunities

The first stage of the PSSE methodology is designed to be participated by the senior management of the company. It identifies the core competency of the company, discusses issues related to Servitization,

overriding problems and challenges. The intention is to give the participants a quick overview of their current situation and discuss the desire of the company to move forward and adopt a new PSS strategy. Stage 1 of the PSSE methodology also explores the potential range of products that is suitable to be used in the new PSS strategy. One of the important deliverables at this stage is to form the Servitization task force team that will be taking part in the rest of the PSSE workshop. The worksheet (*Work Sheet 1.1: Servitization Task Force Members*) used in this stage is adopted from Baines et al. (2005) and Lim (2007).

Stage 2: Identify Servitization Landscape

Stage 2 of the PSSE methodology focuses understanding the customer's needs; and product features that can be used to fulfil these needs. It identifies the drivers and barriers towards Servitization and brainstorms on current and new services for the PSS strategy. This stage of the PSSE methodology also helps the company to classify the types of their new PSS strategy. To allowing determination of the nature of the new PSS for example, Product Oriented PSS, Use Oriented PSS or Service oriented PSS. One of the purposes at this stage is to introduce the new Servitization product service continuum concept to the company. Two worksheets (*Work Sheet 2.1: Understanding Customer's Needs; Work Sheet 2.2: Potential PSS Services)* have been adapted from MEPSS (2004) and re-designed to deliver the action items proposed in this stage.

Stage 3: Design PSS

Stage 3 of the PSSE methodology consists mainly of steps to design the new PSS activities and services. It works on the operation and service delivery system of the new PSS strategy, and identifies profit and non-profit making services to support both the customer and the product. One of the important activities at this stage is to identify the critical

resources that are required to support the new PSS activities. Three worksheets (*Work Sheet 3.1: Design New Activities for PSS; Work Sheet 3.2: Identify Critical Resources for New PSS; Work Sheet 3.3: Identify Critical Success*) has been adapted from the selected methodologies and re-designed to carry out the tasks in this stage.

Stage 4: Review Competitive Strategy

Stage 4 of the PSSE methodology consists of steps to review the current competitive strategy of the company. It conducts the SWOT analysis to give the participants a better understanding of the company's industrial competitive position. It carries this out by identifying the current competitive strategy, and categorises it into 'Product Leadership', 'Customer Intimacy' or 'Operation Excellence'. Two worksheets have been used in this stage, there are, *Work Sheet 4.1: SWOT Analysis* and Work Sheet 4.2: Review Current Competitive Strategy which was adopted from Baines (2005) and Lim (2007).

Stage 5: Assess Competitiveness & Servitizability

Stage 5 of the PSSE methodology is one of the most important stages of the entire methodology. It makes use of the framework of the PSS competitive strategy developed in this research. It focuses on assessing the competiveness of the three competitive dimensions of a PSS strategy, namely, '*Best Packaged Solution', 'Customer Intimacy' and 'Differentiation'*, as well s assessing the Servitizability of the company in terms of its structural and infra-structural policy areas. This stage makes use of the two new assessment charts specifically designed for the PSSE methodology, namely, 'PSS *Competitiveness Measurement Chart' (PSS-CMC)* and '*PSS Servitizability Assessment Chart' (PSS-SMC)*.

Stage 6: Consolidate Outcome and Generate Score Card

The final stage of the PSSE methodology consolidates and generates the final PSS competitiveness by using the 'PSS Competitiveness Assessment Matrix' (PSS-CAM). It produces the final result by placing the assessment results of the PSS competitive dimensions and Servitizability on the x and y axis of the matrix. PSS-CAM will then give the company a clear indication as to whether their new PSS strategy is a *'STAR PSS', 'GOOD PSS', 'POTENTIAL PSS' or a 'WEAK PSS'*. *Work Sheet: PSSE Report Card and Future Actions* consists of information such as the type of PSS strategy, score of competitiveness and Servitizability, PSS activities, critical resources required to deliver the new PSS activities, as well as the future actions planned .

This section has given a brief overview of the pilot 6-stage PSSE methodology. In the next chapter, the result of the primary evaluation of the pilot PSSE methodology will be discussed.

7.7. CHAPTER SUMMARY

This chapter gives a detailed description of the process used in the formation of the pilot PSSE methodology. The pilot PSSE methodology adopts a step-by-step structure, and was developed based on the processes selected from the three methodologies selected in phase 3 of this research programme. As well as the new framework of a PSS competitive strategy and the new PSS competitiveness assessment matrix developed for this research. A brief description of the six stages of the pilot PSSE methodology was provided in Section 7.6.

Chapter 8 will execute phase 4 of the research programme, which is used to perform the primary evaluation of the pilot PSSE methodology by using two industry case studies.

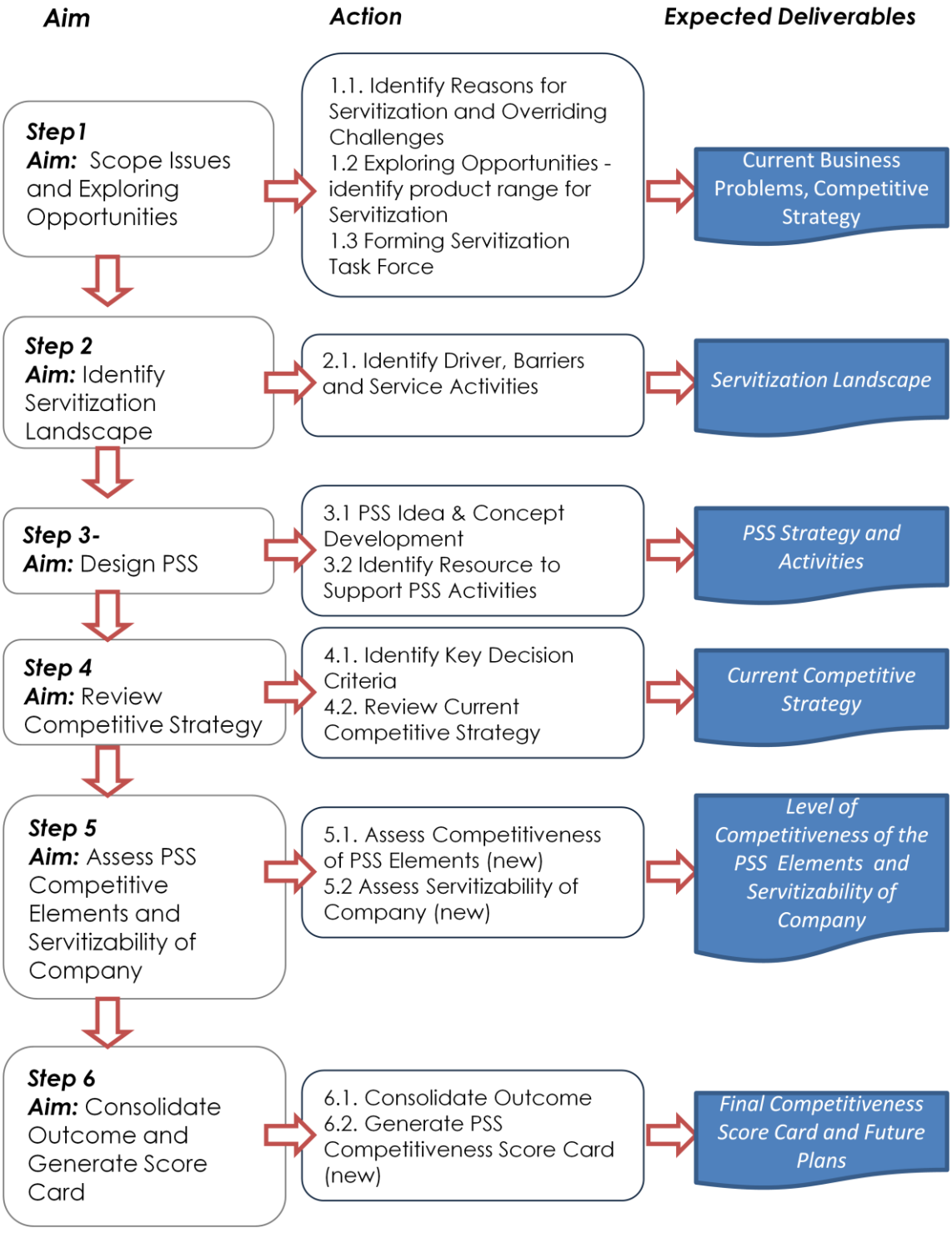


Figure 23: Proposed Structures of the Pilot PSSE Methodology

CHAPTER 8: PRIMARY EVALUATION OF THE PILOT PSSE METHODOLOGY

Chapter 7 described the process of the formation of the pilot PSSE methodology. This chapter presents the execution process and results of phase 4 of the research programme, which is to evaluate the pilot PSSE methodology using actual industry cases. Section 8.1 describes the objective and research method of this phase. Section 8.2 presents the design of the data collection protocol and Section 8.3 discusses the procedure used to select the participating companies. The execution of the case studies is described in Section 8.4 and the analysis of the results is presented in Section 8.5. Section 8.6 discusses the refined structure of the PSSE methodology, and finally, the chapter summary is provided in Section 8.7.

8.1. PHASE 4: OBJECTIVE AND RESEARCH METHOD

Phase 4 of the research programme is to deliver the forth objective of this research, which is to assess and evaluate the effectiveness of the pilot PSSE methodology through rigorous testing and refinement, by using industrial case studies in Singapore. The purpose of this phase is mainly to test the process of the pilot PSSE methodology and to solicit feedback for the refinement of the methodology, before implementing it into a wider application.

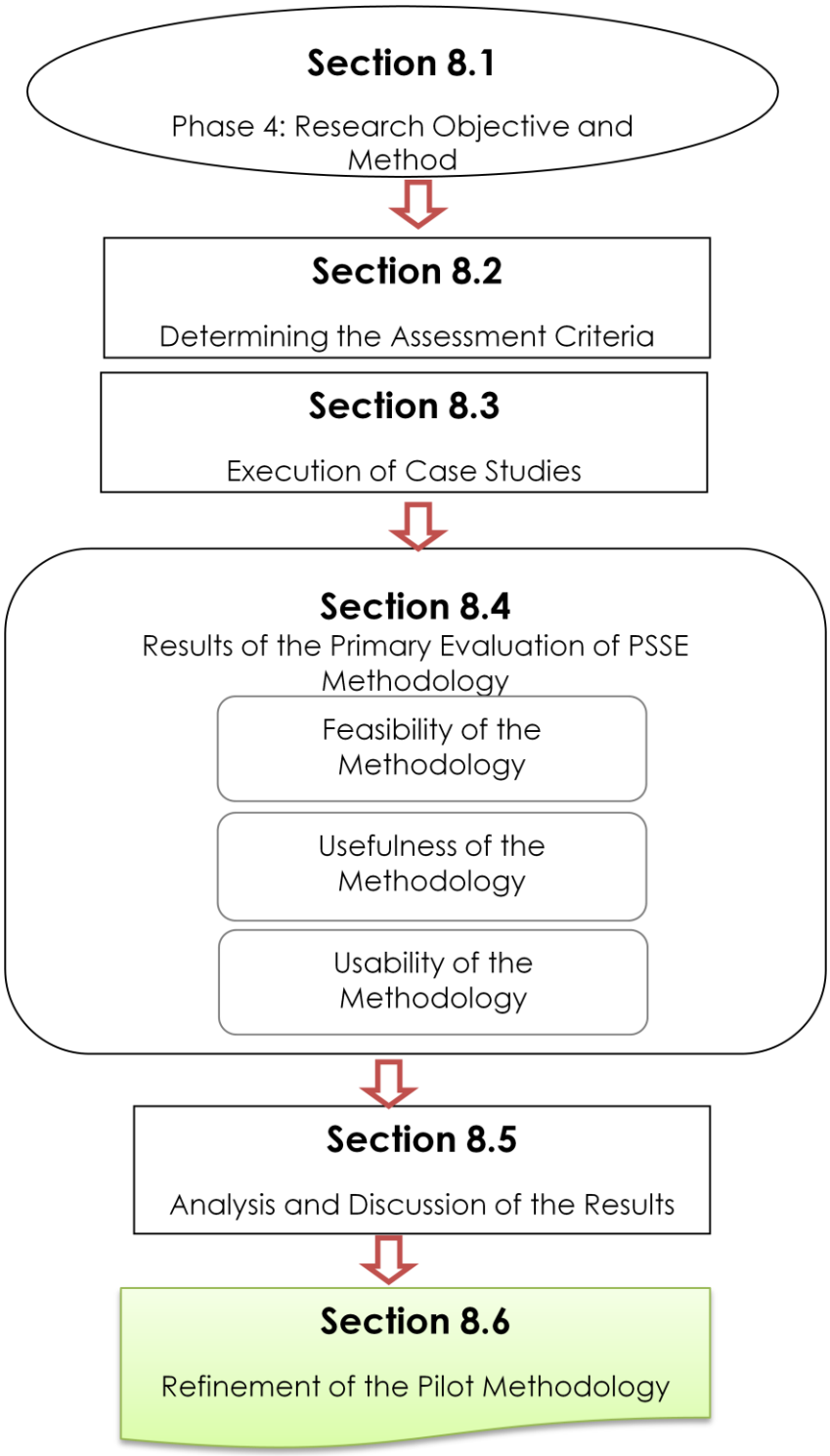


Figure 24: Overview of the Structure of Phase 4 of the Research Programm

Phase 4 of the research programme mainly consists of the following research activities which are illustrated in Figure 24:

- To design the data collection protocol, which includes the assessment criteria, data collection framework and instruments (Section 8.2)
- To select companies for the participation in the testing of the pilot methodology (Section 8.3)
- To execute the case testing (Section 8.4)
- To analyse the strengths and weaknesses of the methodology (Section 8.5)
- To refine the pilot PSSE methodology (Section 8.6)

As described in Section 4.4.4, the research method adopted in this phase is the action research method. In action research, the researcher not only participates in the testing process but also seeks to influence the way to which the testing process is conducted. This research method is ideal in testing new methodology, as the researcher needs to act as a facilitator to catalyze the testing process in order to ensure smooth progress and at the same time to observe and identify any weaknesses in the methodology for improvement. As proposed in Section 4.4.4, the primary evaluation of the PSSE methodology should start with a small number of companies. Thus, two case studies with participant intervention have been chosen for this phase.

8.2. DETERMIINING THE ASSESSMENT CRITERIA

8.2.1 Defining the Assessment Criteria

For the assessment of the practicality of the methodology, the criteria described in Section 5.2.1 will be used. As shown in Table 7, a practical methodology should consist of the following characteristics:

- ***Feasibility*** – The methodology should be able to be followed
- ***Usefulness*** – The methodology should be able to deliver the expected outcomes
- ***Usability*** - The methodology should be easily applied

This set of characteristics can be used as the assessment criteria for the evaluation of the practicality of the PSSE methodology. It has been adopted by many researchers, for example, Adesola (2002) who uses it to assess his business process improvement – MIPIM methodology; Lim (2007) uses it to assess his supply chain strategic positioning methodology; and Chandraprakaikul (2008) uses it to assess her global supply chain management methodology. As the PSSE methodology is also a structured and step-based methodology like the aforementioned three methodologies, this set of assessment criteria is ideal to be used for evaluating applicability of the PSSE methodology.

Table 28 shows the performance indicators of the assessment criteria, which is based on the work of Viseras (2004) and has subsequently been adopted by Adesola (2002), Lim (2007) and Chandraprakaikul (2008).

8.2.2 Data Collection Framework

The purpose of this Section is to design the data collection framework based on the assessment criteria described in Table 28. The data collection framework is designed to answer the What, When, How and Who:

- ***What***: The type of questions that should be asked in order to determine the success of the methodology
- ***When***: When should the data to be collected?
- ***How***: The way the data should be collected
- ***Who***: From whom should the data be collected?

Table 28: Assessment Criteria of the Testing of the Pilot PSSE Methodology

Modified from the work of Adesola(2002), Lim (2007) and Chandraprakaikul (2008)

Assessment Criteria	Performance Indicators	Description
Feasibility	Completeness	The assessment of whether all the stages in the methodology are complete
	Consistency	The assessment of whether the sequence of the stages in the methodology are consistent
	Applicability	The assessment of whether the methodology can be applied to meet the expected outcome
	Contingency	The assessment of whether the methodology is able to provide alternative solutions when some of the stages cannot be implemented
Usability	Time	The assessment of whether time is sufficiently allocated for each stage of the methodology
	Ease of Use	The assessment of whether the tools provided in each stage of the methodology can be easily used
	Understanding	The assessment of whether the purpose of each stage of the methodology is clearly defined
	Flexibility	The assessment of whether the stages of the methodology can be changed during application
Usefulness	Efficiency	The assessment of efficient use of the resources to apply the methodology
	Effectiveness	The assessment of effectiveness in achieving the expected results
	Satisfaction	The assessment of user willingness to use the methodology again
	Success	The assessment of the success in applying the overall process of the methodology
	Practicality	The assessment of whether the tools and worksheet provided in each stage is practical and useful
	Contribution	The assessment of new knowledge gained in using the methodology

The questions that have been designed to collect the required information are provided in Appendix D-1. It has been decided that the assessment shall be carried out at the end of the facilitated workshop and the data should be collected both by the facilitator as well as the participants. Questionnaires will be given out to both the facilitator and the participants at the end of the workshop to collect the desired data. Table 29 provides the structure of the data collection framework.

Table 29: Data Collection Framework

	Feasibility	**Usability**	**Usefulness**
What	To determine whether the methodology could be applied Questions: Appendix D-1 Part 1	To determine whether the methodology could be easily followed Questions: Appendix D-1 Part 3	To determine whether the methodology is able to deliver the expected outcomes Questions: Appendix D-1 Part 2
When	At the end of the workshop	During and at the end of the workshop	At the end of the workshop
How	By asking the participant and facilitator to fill in the questionnaire provided; Participant Observation; Interview	By asking the participant and facilitator to fill in the questionnaire provided; Participant Observation; Interview	By asking the participant and facilitator to fill in the questionnaire provided; Participant Observation; Interview
Who	Facilitators; Participants	Facilitators; Participants	Facilitators; Participants

8.2.3 Data Collection Instrument

The questionnaire provided in Appendix D-1 is designed based on the criteria described in Table 28. For the primary evaluation of the PSSE methodology, the researcher has acted as a facilitator to conduct the

facilitated workshop and helped in guiding the participants through the implementation of the PSSE methodology. Various data collection instruments have been used during the testing session to collect data. For example, as this is the first time the PSSE methodology has tested, apart from acting as a facilitator, the researcher has also been acting as an observant to monitor the reaction of the participants. During the process of post evaluation assessment, the researcher also helped in explaining the rationale behind the questions provided in the questionnaire. Interviewing and note taking during and after workshop are also effective instruments in collecting data related to the feasibility, usefulness and usability of the PSSE methodology.

8.3. EXECUTION OF CASE STUDY

8.3.1 Selection of Companies

The focus of this research is to take place in an actual manufacturing environment in Singapore. In order to select the most appropriate companies to take part in the testing, the following company selection criteria have been developed:

1. Singapore's product manufacturers who own manufacturing facilities which are in or outside Singapore, or subsidiary companies residing in Singapore with their parent company owning manufacturing facilities outside Singapore.

2. The company should be involved in providing services on top of their products and have the intention to provide more services, or set up a new professional service unit.

3. Preferably a company which has no prior road mapping experience and is currently looking for a

systematic and effective methodology to determine their Servitization capability.

8.3.2 Process Used in Engaging the Companies

The process used in engaging the companies for the primary evaluation of the methodology is as follows:

First, the two companies involved in this research were selected from the client database of SIMTECH. As these are the first two companies involved in the testing, the researcher has decided to pick those companies that the researcher has close contact with the management as well as good knowledge in their products and processes.

Second, the researcher then will brief the management of the companies with the intention of engaging them in the testing of a new methodology via telephone or face to face meeting.

Lastly, after securing the date of the testing, the researcher would then assist the company in some background information such as the current product and services provided and the level of customer satisfaction etc. in order to prepare for the evaluation workshop. Emails will also be sent to the companies to clarify information pertaining to new product features, manufacturing practices and facilities, and service practices etc. prior to the workshop.

8.3.3 Profile of the Selected Companies

Two companies have participated in the primary evaluation of the PSSE methodology. These are the Water Heater Co. and the CAD CAM Controller Co. Both of them have also participated in the semi-structured interview conducted in the first phase of this research. Their brief profile is shown in Table 30.

Table 30: Profile of the Selected Companies for the Primary Evaluation of the Pilot PSSE Methodology

	Case P1: Water Heater Co.	Case P2: CAD CAM Controller Co.
Range of Products	Water Heaters	CAD CAM Software
Range of current services	Warranty, Repair, Training, Marketing support	Total Process Solutions
Main Contact Point	Sales & Marketing Director	Managing Director
Location of Manufacturing Facilities	Singapore	UK
Number of Employee	~30	-900
Awareness of PSS and Servitization Prior to Interview	No	No

8.4. EXECUTION OF THE PRIMARY EVALUATION

This Section provides a brief description of the two cases. Detailed description of the case study and their case study report can be found in Appendix C.

8.4.1 Case P1: Water Heater Co.

Water Heater Co. is the first water heater company in Singapore. The company was founded in 1969. The company designs, manufactures, distributes and sells electrical instant water heaters. As the water heaters became commoditized and the sales are becoming stagnant, the company has the intention to provide more services to maintain its

competitiveness. Since it is the first water heater company in Singapore, it has a huge installed base and the older generation preferred brand of water heater. Apart from investigating the huge replacement market, the company is considering to re-structure its service unit to turn it into a profit making business unit rather than the current supporting non-profit generating unit. The company is currently working with the housing developer to look into providing total solution in delivering centralised heating services for swimming pool, washing and showering etc. too.

Stage 1: Scope Issue and Exploring Opportunity

The core competency of the company is its capability and know how in developing instantaneous electric water heaters. It is one of the Asia's first water heater manufacturers and has obtained the British BE marking for water heaters, whilst distributing over a large network in South East Asia. Current overriding problems are that the sales of the water heater are decreasing, and the profit margin at an alarming low level. There are occasions that the company has had to close sales at a margin close to no profit just to keep the production running. The current competitive strategy identified is Product Leadership as the company constantly rolls out new water heater models and performs face lift to its existing water heater range to keep its business running. The company has identified the new multi-point water heater MP2 as the potential product for selling as a PSS.

Stage 2: Identify Servitization Landscape

The new PSS services mainly targeted, replacing the existing old water heater with the new multi-point water heater, through leasing, instalment, or selling "hot water per usage". Most of the existing old water heater owners and users are old people. They have strong brand loyalty and

always wanted the same brand of water heater or even ask for same discontinued old models to replace their existing old heater.

Stage 3: Design PSS

The multi-point heater MP2 has to be modified to include new feature for tracking of the usage of the hot water when it is to be used in a PSS. The company's existing service and marketing team can double up as the sales and service team for the new PSS. The new PSS activities identified, include new contract template for selling the availability of the hot water, new costing and billing model, product modification, product installation, product maintenance, product take back and part replacement etc.

Stage 4: Identify Critical Success Factor

The most critical success factor identified is Cost of Investment. The company currently is in a very critical financial situation. Any investment involved in new business set up has to be carefully assessed and justified. As the new PSS involves huge initial set up cost (for example, free installation and replacement of old single point water heater with new multi point water etc), and do not foresee to breakeven within a year, the chance is that if the company does not have enough fund to sustain the operation, the new PSS will be not be to implemented long enough to reap its potential profit. The second critical success factor identified is Customer Acceptance as the majority of the current existing clients are users who are above 50 years old; any new business model has to be able to bring some immediate benefits to this group of users to convince to switch to a new system.

Stage 5: Assess PSS Competitiveness and Servitizability

The overall PSS competitive elements are assessed to be moderately above average. In the category of best package and Customer Intimacy, the company is leading its competitor as it has the strong

brand name, recognised product and a wide user base. However in term of Differentiation, it was assessed as being slightly below average as the company currently is not performing financially well plus the new PSS business model will take a long time (at least 2 years by estimation) to reap its promised financial benefit.

Although the company has existing installation, repair and customer service personnel, Servitizability is rated as slightly below average too. The production facilities and processes are slim, labour intensive and high-mix-low-volume oriented, as a result, it can be re-scheduled easily to produce the new heater for PSS. The company does not have its own R&D unit but it has been worked closely with one of the local research institutes. Although the company appeared to have an edge in transforming easily to support the new PSS strategy, due to the mentality and mindset of the old service team, it is rated below average.

Stage 6: Consolidate Outcome and Generate Score Card

As both the final score of the 'Competitiveness of the PSS Elements' and Servitizability were all rated slightly below average, the PSS strategy was assessed to be as a 'WEAK PSS'. However, this is a borderline case, as a few more points along both the x and y axes will put the strategy into the category of a 'STAR PSS'. In situation likes this, it is recommended that assessment of Stage 5 should be carried out by a larger cross-functional team in order to produce more accurate results.

8.4.2 Case P2: CADCAM Controller Co.

CADCAM Controller Co. is one of the world's leading suppliers of advanced CADCAM solutions for manufacturing industry. The South East Asia branch has its head quarter based in Singapore, and provides professional manufacturing processing services to the Aerospace and Medtech industry in Singapore. Although the company participated in

the primary evaluation, the proposal put up by the company is not really a true PSS business cases as the product involved in this discussion is not a tangible product but intangible software. Basically the company has the intention to replace the existing business model of selling CAD/CAM controller software license with a provision of a one stop professional solution in improving the productivity of the clients. Although it is not a true PSS case, the company has actively participated in the post workshop assessment of the methodology and have given many valuable inputs especially in the improvement of the structure and facilitation process of the methodology.

8.5. RESULTS OF THE PRIMARY EVALUATION OF THE PSSE METHODOLOGY

This Section discusses and analyses the result of the primary evaluation of the methodology with the two participated companies. The overall score of the assessment test is shown in the figure below.

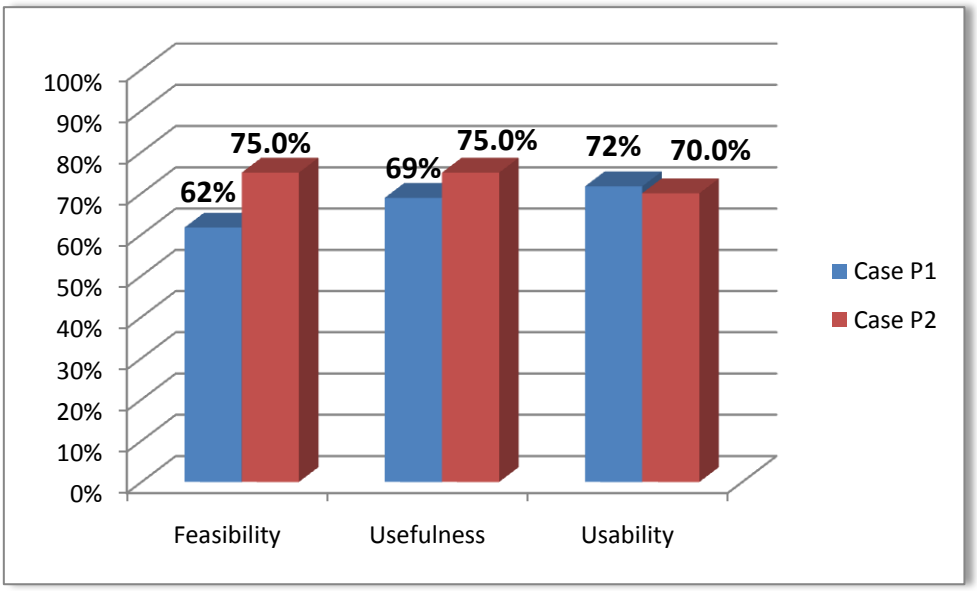


Figure 25: Overall Results of the Primary Evaluation of the PSSE Methodology

8.5.1 Feasibility of the Pilot PSSE Methodology

The first part of the primary evaluation is to assess whether the PSSE methodology is feasible using performance indicators like 'Consistency', 'Completeness', 'Contingency' and 'Applicability'. As shown in Figure 25, the average score from the three participants of Case P1 is 69% and the average score from the two participants of Case P2 is 75%. The average score of the two participated companies is 68.3% and the result is tabulated in Table 31. The above average score demonstrates that the methodology can be followed but there is room for further improvement. Following are some of the comments extracted from Q1.5 of the questionnaires which support the findings:

- Case P1-Q1.5 - "The stages in the methodology are consistent and generally can be followed"
- Case P2- Q1.5 – "Although it appeared to be quite complicated, the overall design of the PSSE methodology is good and can be applied"

The detailed result of the feasibility assessment test can be found in Appendix D2.

8.5.2 Usefulness of the Pilot PSSE Methodology

The second part of the primary evaluation is to assess whether the PSSE methodology is useful when using performance indicators like 'Effectiveness', 'Contribution', 'Efficiency', 'Practicality', 'Success' and 'Satisfaction'. As shown in Figure 25, the average score from the three participants of Case P1 is 61.7% and the average score from the two participants of Case P2 is 75%. The average score of the two participated companies is 71.9% and the result is tabulated in Table 31.

The above average score demonstrates that the methodology is useful and able to deliver the expected results, although feedback from Case P2 shows that they would like to see improvement in term of the facilitation process. Below are some of the comments extracted from Q2.7 of the questionnaires which support the findings:

- Case P1-Q2.7 - "The PSSE methodology is a useful methodology, it is practical and able to give useful expected results"
- Case P2- Q2.7 – "Rather satisfied with the result achieved. However, would like to see more improvement in terms of the facilitation process"

The detailed result of the feasibility assessment test can be found in Appendix D2.

8.5.3 Usability of the Pilot PSSE Methodology

The third part of the primary evaluation is to assess whether the PSSE methodology can be usable by using performance indicators like 'Ease of Use', 'Time', 'Understanding' and 'Flexibility'. As shown in Figure 25, the average score from the three participants of Case P1 is 72% and the average score from the two participants of Case P2 is 70%. Therefore the average score of the two participated companies is 70.8% and the result is tabulated in Table 31. The above average score demonstrates that the methodology is and can be followed with ease. Following are some of the comments extracted from Q3.5 of the questionnaires which support the findings:

- Case P1-Q3.5 - "The time allocated for each stage is sufficient, the tools provided are easy to use too, although we need assistance from the facilitator to

provide us with guidance when filling in the worksheet, we think the methodology is rather useful"

- Case P2-Q3.5 – "Good tools and moderately useful worksheets. However, I have used some visual act tools in other strategy management workshops, maybe it is a good idea to incorporate some of these tools too in the PSSE methodology"

The detailed result of the usability assessment test can be found in Appendix D2.

8.5.4 Strength of the Pilot PSSE Methodology

The strength of the PSSE methodology identified during the primary evaluation is the provision of the 'PSS Competitiveness Assessment Matrix' (PSS CAM) in stage 6. Both the participated companies commented that this is a rather good design which provides clear indication of the final competitiveness position of their new PSS strategy. The flow of PSSE methodology is also logical and able to perform the intended outcomes within the allocated time and with the allocated resources.

Table 31: Assessment Results of the Primary Evaluation of the Pilot PSSE Methodology

Feasibility Criteria	Case P1	Case P2	Average Score
Consistency	3.0	4.5	3.8
Completeness	3.0	4.0	3.5
Contingency	2.3	3.0	2.7
Applicability	4.0	3.5	3.8
			68.3%
Usefulness Criteria	**Case P1**	**Case P2**	**Average Score**
Effectiveness	3.7	4.0	3.8
Contribution	4.0	4.5	4.3
Efficiency	4.0	2.5	3.3
Practicality	3.0	3.5	3.3
Usefulness	3.0	4.5	3.8
Satisfaction	3.0	3.5	3.3
			71.9%

Usability Criteria	Case P1	Case P2	Average Score
Ease of Use	3.7	5.0	4.3
Time	4.0	2.0	3.0
Understanding	3.7	4.5	4.1
Flexibility	3.0	2.5	2.8
			70.8%

Table 32: Qualitative Comment of the Primary Evaluation of the PSSE Methodology

Questions	Case P1	Case P2
Feasibility - Q1.5	The stages in the methodology are consistent and generally can be followed	Although appeared to be quite complicated, the overall design of the PSSE methodology is good and can be applied
Usefulness – Q2.7	The PSSE methodology is useful; we felt that it is rather practical and able to give useful results.	Rather satisfied with the result achieved. However, would like to see more improvements in terms of the facilitation process
Usability – Q3.5	The time allocated for each stage is sufficient; the tools provided are easy to use too, although we need assistance from the facilitator to provide us with guidance all the times.	Good tools and moderately useful worksheets. I have used visual tools in other workshop when attending strategy management workshops, maybe it is a good idea to incorporate some of these tools too

8.5.5 Weaknesses of the Pilot PSSE Methodology

Weaknesses of the methodology have been identified based on post workshop interviews conducted as well as observations performed by the researcher during the primary evaluation. As a whole, during the facilitation process, it was observed that a lot of times have been allocated to the participant to fill in the worksheets and to consolidate the results from the worksheets generated by the participants, especially during stage 3, 4 and 5.

8.6. OPPORTUNTIES FOR REFINEMENT OF THE PILOT METHODOLOGY

Table 33 summarises the proposed changes of the pilot PSSE methodology. Basically, opportunities arising to refine the pilot PSSE methodology can be categorised into the following areas:

- **Design of New PSSE Facilitator Guide**
  New PSSE Facilitator guide will be developed to help the facilitator in facilitating a PSSE workshop more effectively.

- **Design of New PSSE Facilitation Charts**
  A set of new facilitation charts will be developed to assist the facilitation process of the PSSE methodology more efficiently:

  Stage 1: Scope Issue

  Stage 2: Identify Servitization Landscape

  Stage 3: Design PSS

  Stage 4: Review Competitive Strategy

  Stage 5/6: Assessment of PSS Competitive Elements and Servitizability Charts

  Stage 7: PSS Competitiveness Measurement Matrix

  The purpose of the facilitation charts is to make the PSSE methodology more usable when delivered via a facilitated workshop.

- **Improve on the Facilitation Process**
  With the development of the new facilitation charts, Instead of asking participants to work separately on individual worksheets, interactive sessions can be arranged

by asking the participants to work on the facilitation charts together.

Refinement of the Worksheets

Existing worksheets will be refined to incorporate changes proposed by the participants in stage 3. Both PSS-CMC and PSS-SMC worksheets will be improved by adding in a new performance indicator at the bottom of the measurement chart to clearly indicate the level of the competitiveness and Servitizability.

- **Re-structure the flow of the PSSE methodology**
  The flow of the PSSE methodology can be improved so that the aim and function of the stages can be more precisely defined. The name of the stages of the PSSE methodology will be changed to reflect the action performed within the stage itself. Furthermore, Stage 5 will be split into two separate stages with more specific aims as well as allowing more discussions to take place as Stage 5 contains two of the most important determining factors of the PSSE methodology, and their final outcomes directly impact on the final stage of the PSSE methodology, which is the final competitive position of a new PSS strategy.

Table 33: Summary of Proposed Changes to the Pilot PSSE Methodology

Stages	Proposed Changes	Reasons
Stage 1 Scope Issues	✓ Introduce Facilitation Chart 1 – Scope Issue	To provide effective facilitation and to allow the management team to focus on interactive discussion rather than working on individual worksheets
Stage 2 Identify Servitization Landscape	✓ Introduce new facilitation chart 2 – Servitization Landscape	To provide effective facilitation and to give participants a clearer picture of what services and PSS elements are being discussed. A more systematic way of presenting the PSS strategy and its activities
Stage 3 Design PSS	✓ Introduce new facilitation chart 3- Design PSS	To provide effective facilitation and to give a complete picture of the new PSS design
Stage 4 Identify Critical Success Factor	✓ Rename the stage to "Review Competitive Strategy" ✓ Introduce new Facilitation Chart 4 – Review Competitive Strategy	To focus on reviewing current competitive strategy
Stage 5 Evaluate Competitiveness	✓ Split the stage into two stages; namely, Stage 5 : "Assess PSS Competitive Elements" and Stage 6 : "Assess the Servitizability of Company" ✓ Improve both the PSS CMC and PSS-SMC worksheets by adding in a new L,M,H ranking bar below the table ✓ Introduce new Facilitation Chart 5- Assess PSS Competitive Elements ✓ Introduce new Facilitation Chart 6-Assess the Servitizability of Company	To make the aim and action for stage 5 more precise
Stage 6 Generate PSS Score Card	✓ Rename the stage to Stage 7 : "Determine Type of PSS Competitive Strategy" ✓ Introduce new Facilitation Chart 7-PSS Competitiveness Measurement Matrix	To make the aim and action of stage 6 more precise

8.7. THE STRUCTURE OF THE REFINED PSSE METHODOLOGY

The main outcome of this primary evaluation is the creation of the refined version of the PSSE methodology. Based on the users' feedback and observation by the researcher, the pilot PSSE methodology has been restructured into a seven-stage methodology:

- *Stage 1: Scope Issues*
- *Stage 2: Identify Servitization landscape*
- *Stage 3: Design PSS*
- *Stage 4: Review Competitive Strategy*
- *Stage 5: Assess PSS Competitive Elements*
- *Stage 6: Assess Servitizability of company*
- *Stage 7: Determine Type of PSS Competitive Strategy*

Figure 26 provides an illustration of the refined PSSE methodology and a comparison of the structure between the pilot and refined PSSE methodology can be found in Table 34.

8.8. CHAPTER SUMMARY

This chapter has presented the results of the primary evaluation of the PSSE methodology. It has discussed the results of the two primary case studies and proposed changes to the pilot methodology. The proposed changes include the development of the new PSSE Facilitator's Guide and a set of new facilitation charts as well as refining existing worksheets. In the next chapter, the development of the new facilitator charts will be discussed together with the structure of the refined PSSE methodology.

Table 34: Pilot PSSE Methodology Vs Refined PSSE Methodology

Pilot PSSE Stages	STEP	Refined PSSE Stages	STEP
Stage 1: Scope Issues and Exploring Opportunities	1.1. Identify Reasons for Servitization and Overriding Challenges 1.2 Exploring Opportunities - identify product range for Servitization 1.3 Forming Servitization Task Force	**Stage 1: Scope Issues**	Step 1: Identify Core Competency Step 2: Discuss Reasons for Servitization Step 3: Discuss Overriding Problems and Challenges Step 4: Identify Products for PSS Step 5: Form the Servitization Task Force Team
Stage 2: Identify Servitization Landscape	2.1. Identify Driver, Barriers and Service Activities	**Stage 2: Identify Servitization Landscape**	Step 1: Identify Drivers and Barriers towards Servitization Step 2: Brainstorm current and new services for PSS Step 3: Identify new PSS Model
Stage 3: Design PSS	3.1 PSS Idea & Concept Development 3.2 Identify Resource to Support PSS Activities	**Stage 3: Design PSS**	Step 1: Understand Customer Needs Step 2: Design New PSS Activities Step 3: Assess Critical Resources for new PSS Activities
Stage 4: Identify Key Decision Factors	4.1. Identify Key Decision Criteria 4.2. Review Current Competitive Strategy	**Stage 4: Review Competitive Strategy**	Step 1: Review Current Competitive Strategy Step 2: Perform SWOT Analysis Step 3 : Identify desired PSS competitive strategy
Stage 5: Assess Competitiveness & Servitizability	5.1. Assess Competitiveness of PSS Elements 5.2 Assess Servitizability of Company	**Stage 5: Assess PSS Competitive Elements**	Step 1: Identify Critical Success Elements for PSS Competitive Dimensions Step 2: Assess PSS Competitive Dimension
		Stage 6: Assess Servitizability of Company	Step 1: Identify Structure and Infra-structure policy areas Step 2: Assess Servitizability
Stage 6: Consolidate Outcome and Generate Score Card	6.1. Consolidate Outcome 6.2. Generate PSS Competitiveness Score Card	**Stage 7: Determine Type of PSS Competitive Strategy**	Step 1: Perform PSS Competitive Matrix Analysis Step 2: Generate Final PSS Competitive Score Card Step 3: Discuss on Future Action

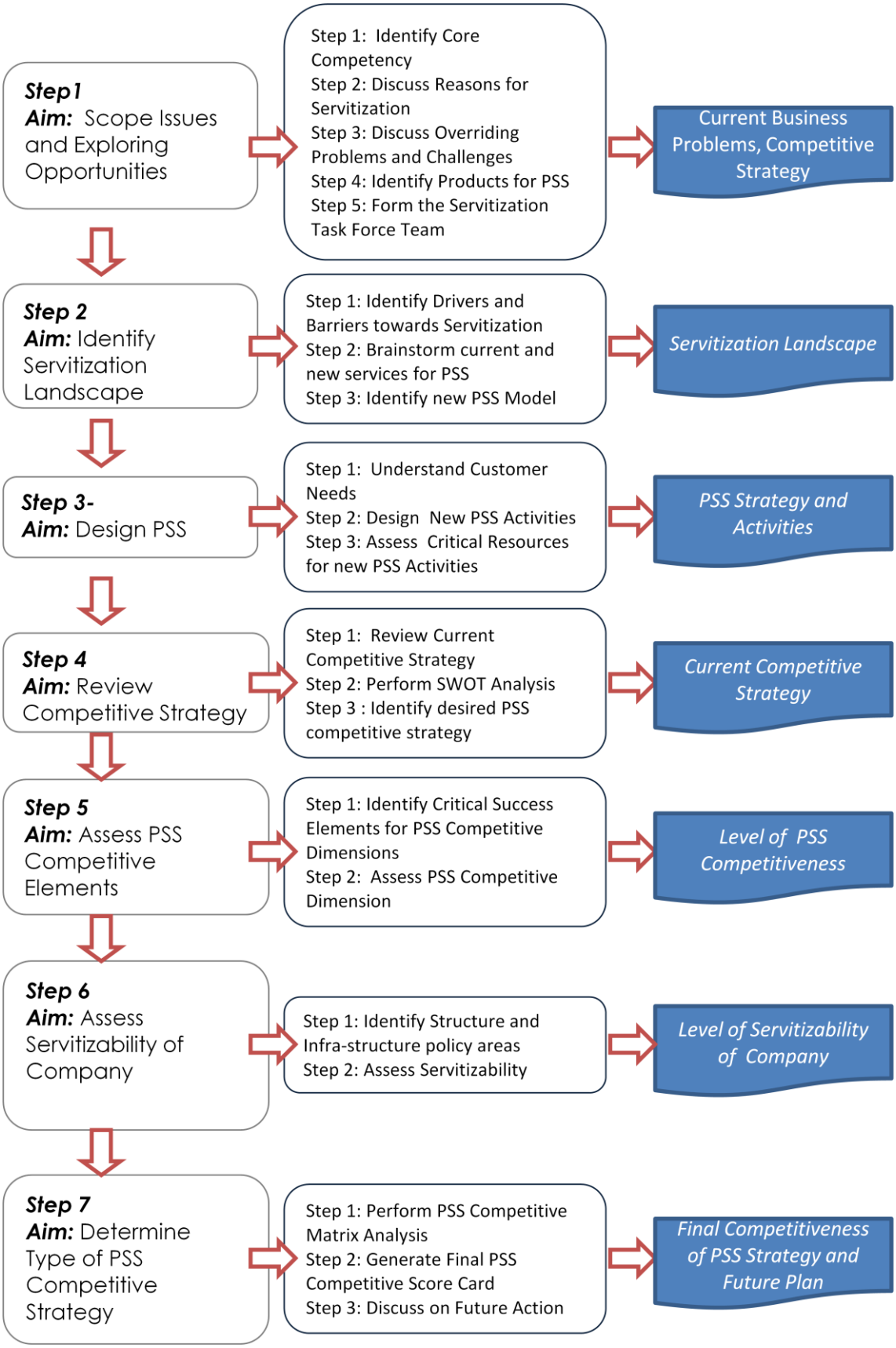


Figure 26: The Structure of the Refined PSSE Methodology

CHAPTER 9: REFINEMENT AND ILLUSTRATION OF THE FINAL PSSE METHODOLOGY

Chapter 8 discussed the execution process and results of the primary validation of the pilot PSSE methodology. The suggestions made by participating companies in improving the pilot PSSE methodology were also presented. This chapter deals with the execution of the secondary evaluation of the methodology, which is the last phase of the research programme.

Section 9.1 describes the objective and method for realising this phase of research. Section 9.2 discusses the new facilitation tool developed for improving the overall feasibility and usability of the PSSE methodology in a facilitated workshop. The data collection protocol and profiles of the companies selected for participating in this phase are presented in Section 9.3. The results of the execution of the case studies are then discussed in Section 9.4. Section 9.5 presents the final findings of the cross case analysis and highlights areas for improvement. The final structure of the PSSE methodology is presented in Section 9.6. A chapter Summary is provided in Section 9.7.

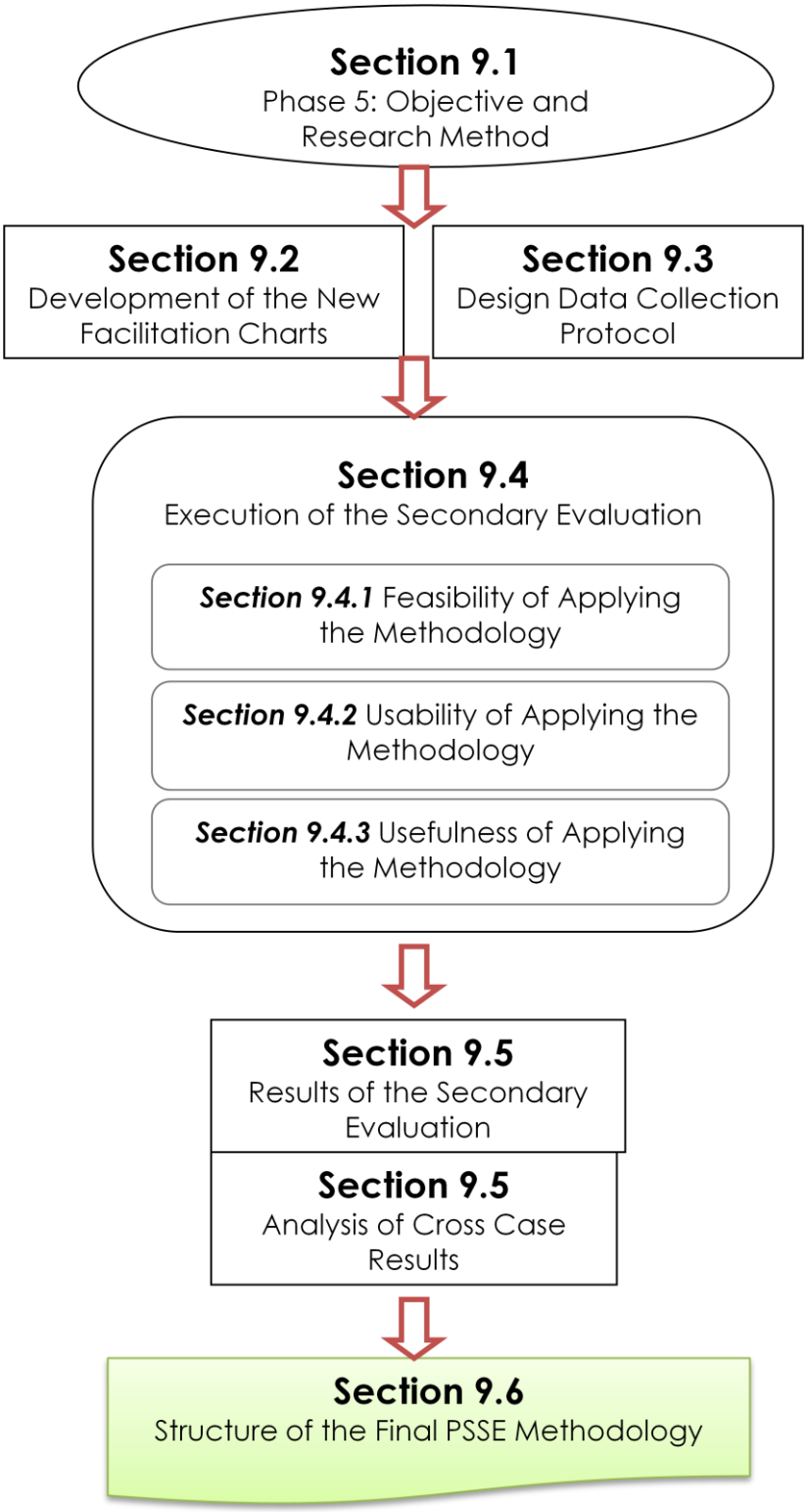


Figure 27: Overview of the Structure of Phase 5 of the Research Programme

9.1. PHASE 5: OBJECTIVE AND RESEARCH METHOD

The objective of phase 5 of the research programme is to test the refined PSSE methodology in wider industrial applications to validate its practicality and robustness. The main focus of this phase is to evaluate the PSSE methodology independently from the researcher who has developed it. Although the method of conducting the secondary evaluation is slightly different from the last phase, similar sets of assessment criteria and data collection protocol could be adopted from the primary evaluation. In addition, in order to obtain more accurate data during the secondary evaluation, the selection of companies is more stringent in this phase as compared to the primary evaluation phase. The structure of this phase of the research programme is illustrated in Figure 27.

The primary validation was judged to be successful, however, due to the fact that the primary evaluation of the methodology was facilitated by the researcher, the success could have been achieved by means of the facilitation process and guidance due to the familiarity of the researcher with the structure of the methodology and the usage of the tools and worksheets provided. As a result, in contrast to the primary evaluation, the secondary evaluation of the PSSE methodology is conducted without researcher intervention.

The evaluation of the PSSE methodology will be conducted by independently trained and untrained facilitators in this phase. The purpose is to provide a more objective judgement and to further assess the practicality of the methodology. The role of the researcher in this phase was very much reduced to acting as an observer come participant who will participate in the workshop to mainly maintain

contacts with the project team members and to observe the flow of discussion and implementation of the methodology. Table 35 gives the facilitation plan of the secondary evaluation of the refined PSSE methodology.

Table 35: The Facilitation Plan of the Secondary Evaluation

Case	Facilitator	Role of Researcher
Case S1	Trained facilitator	Assistant Facilitator
Case S2	Trained facilitator	Assistant Facilitator
Case S3	Untrained facilitator	Observer-as-participant
Case S4	Untrained Attachment Student	Observer-as-participant

9.2. DEVELOPMENT OF THE NEW FACILITATION CHARTS

A set of new facilitation charts has been developed to make the PSSE methodology more usable when delivered via a facilitated workshop. The purpose of the facilitation charts is to assist the facilitator in conducting the PSSE Workshop using the PSSE methodology. Altogether, a set of seven facilitation charts has been created:

- Facilitation Chart 1: Scope Issues
- Facilitation Chart 2: Servitization Landscape
- Facilitation Chart 3: Design PSS
- Facilitation Chart 4: Review Competitive Strategy
- Facilitation Chart 5: PSS Competitive Elements Measurement Chart (PSS-CMC)
- Facilitation Chart 6: PSS Servitizability Measurement Chart (PSS-SMC)
- Facilitation Chart 7: PSS Strategy Competitiveness Assessment Matrix (PSS-CAM)

The effectiveness of the new facilitation charts will be evaluated during the secondary evaluation of the PSSE methodology to assess their effectiveness and usability.

9.2.1 Facilitation Chart 1: Scope Issues

The purpose of Facilitation Chart 1 is to assist the facilitator in kicjk starting the discussion of stage 1 of the PSSE workshop. Its design is shown in Figure 28 and it contains the following topics for discussion:

- ***Core Competency*** – The core competency of the company
- ***Reasons for Moving towards Servitization –*** The reason of developing the new PSS
- ***Overriding Challenges and Problems*** – The current overriding challenges and problems faced by the company
- ***Identification of Products for Servitization*** – The product that will be used in the design of a new PSS
- **The PSS Project Team** - The cross-functional project team that is responsible in developing the new PSS strategy

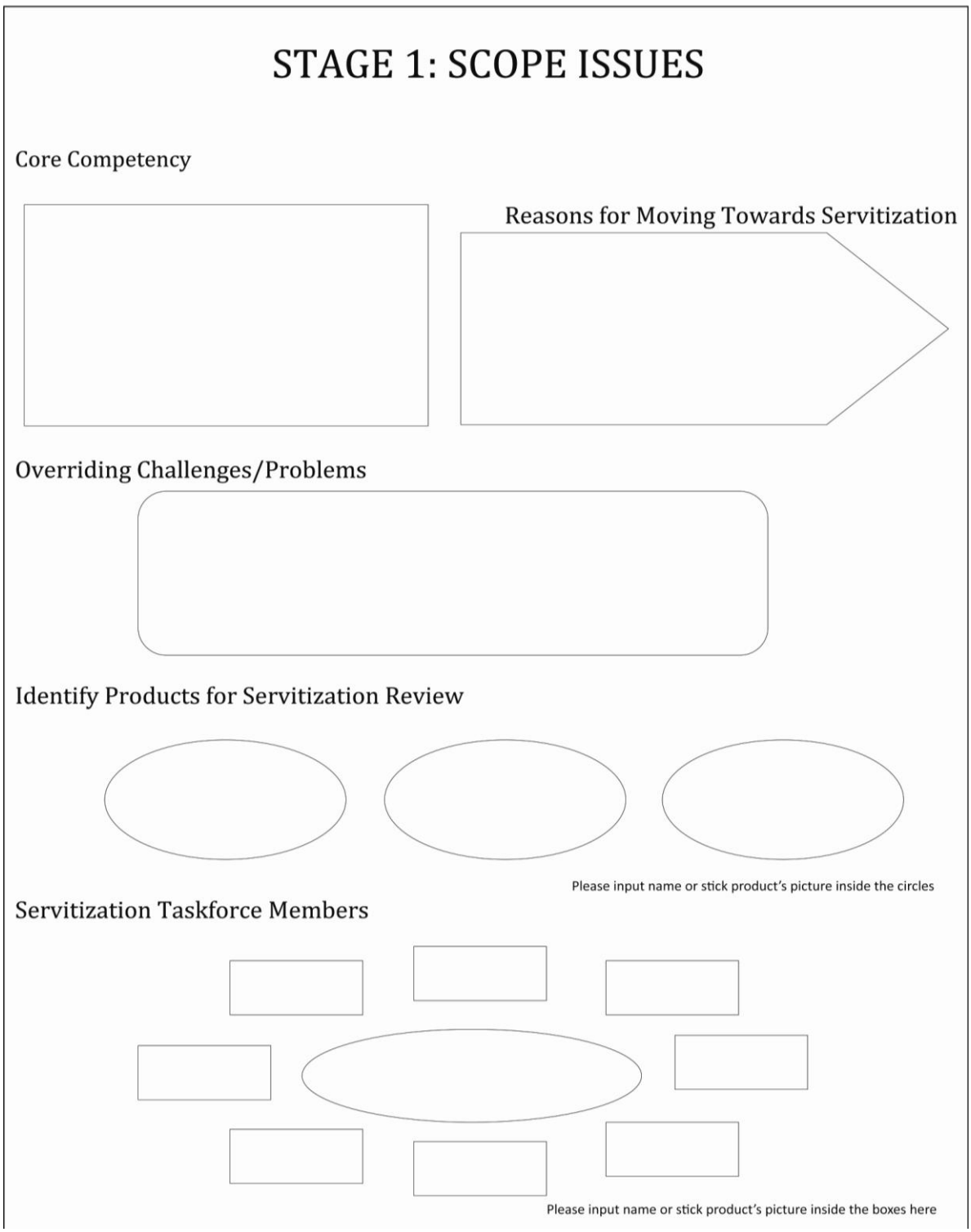


Figure 28: Facilitation Chart 1: Scope Issues

9.2.2 Facilitation Chart 2: Servitization Landscape

Facilitation Chart 2 is intended to assist the facilitator in kick starting the discussion of stage 2 of the PSSE workshop. It allows the facilitator to conduct the brainstorming session with the participants, involving issues related to the identification of the Servitization landscape of the company. When used together with the worksheets provided in stage 2, namely, worksheets 2.1-2.3, the chart allows the facilitator to discuss important issues such as drivers, barriers, customer's needs and new services in a holistic manner. The design of the facilitation chart is shown in Figure 29 and it contains the following topics for discussion:

- ***Drivers*** – The drivers of moving toward Servitization
- ***Barriers*** – The barriers the company has to overcome before it can move towards Servitization
- **Customer's Needs** – The customer's needs that the new PSS strategy need to fulfill
- ***Product & Services*** - Product identified in stage one, and the range of services that can be provided together with this product to form the new PSS
- ***Type of PSS*** - Type of PSS model. This is identified by the end deliverables of the new PSS. The new PSS can be classified under *Product Oriented PSS, Use Oriented PSS or Result Oriented PSS*

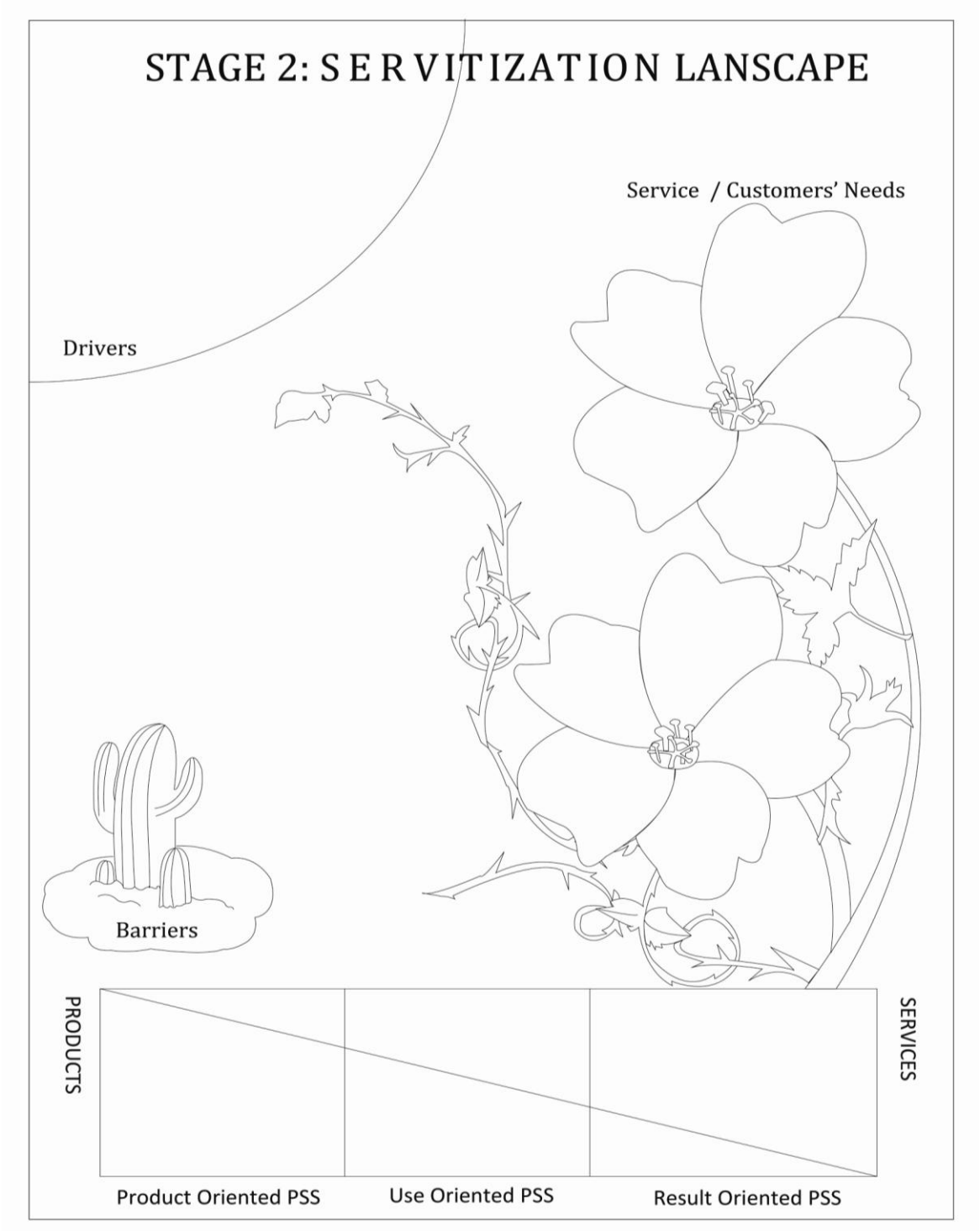


Figure 29: Facilitation Chart 2: Servitization Landscape

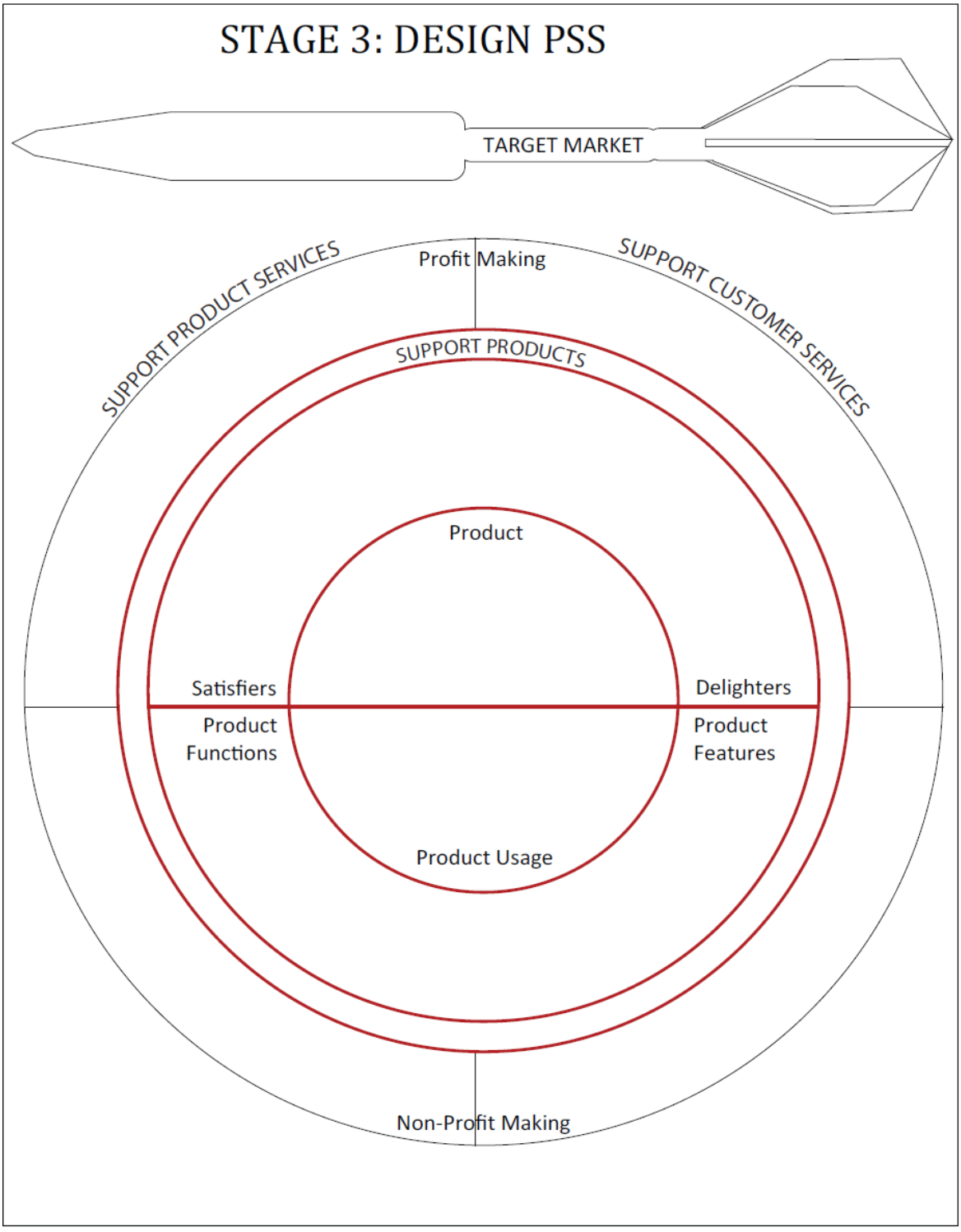


Figure 30: Facilitation Chart 3: Design PSS

9.2.3 Facilitation Chart 3: Design PSS

The intention of Facilitation Chart 3 is to assist the facilitator in conducting the discussion of the stage 3 of the PSSE workshop. The design of the facilitation chart is shown in Figure 30 and it contains the following topics for discussion:

- **Target market** – the targeted market of the new PSS
- **Product usage** – the intended use of the product
- **Product features** – list of features of the product that meant to deliver the intended use of the product
- **Services support products** – services that are intended to support the proper functions of the product, i.e. routine maintenance
- **Services support customers** – services that are intended to support the customers, i.e. product training
- **Profit and nonprofit making services** – to categorize all services listed above under profit making and nonprofit making

9.2.4 Facilitation Chart 4: Review Competitive Strategy

The intention of this facilitation chart is to assist the facilitator in conducting the discussion of stage 4 of the PSSE workshop. This chart allows the facilitator to guide the participants in discussing issues relating to the current and desired competitive strategy. It provides a simple scenario diagram to give the participants a quick overview of the competitive position of the company by going through the 'SWOT Analysis', the analysis of competitive gap, the current competitive strategy and the desired PSS competitive advantages. The facilitation chart is to be used together with worksheets 4.1-4.3, which is provided in Appendix B. The purpose of this chart is also to prepare the participants

for the discussion of the next two stages, which are the assessment of the PSS competitive elements and Servitizability of the companies by giving them an overview of their current strength and weaknesses, as well as their current and desired competitive position.

The design of the facilitation chart is shown in Figure 31. It contains the following topics for discussion:

- ***Current Competitive Strategy -*** The current competitive strategy of the company, for example, '*Product Leadership', 'Customer Intimacy' or 'Operation Excellence*'. The result of the current competitive strategy is obtained by using worksheet 4.2- Review Current Competitive Strategy
- ***Desired PSS Competitive Strategy*** - The desired competitive elements of the PSS strategy, '*Best Packaged Solution', 'Customer Intimacy' and 'Differentiation'*
- ***SWOT Analysis*** – The *strengths, weaknesses, opportunities and threats* of the company. The discussion is assisted by using the *Worksheet 4.1-SWOT Analysis*
- **Competitive Gap Analysis** – The competitive gap between the company and its competitor in the aspects of "We match", "We exceed" and "We lag"

By discussing the topics described above, participants are able to gain a clearer picture of the company's overall competitive position as well as its strengths and weaknesses in achieving the desired PSS competitive strategy.

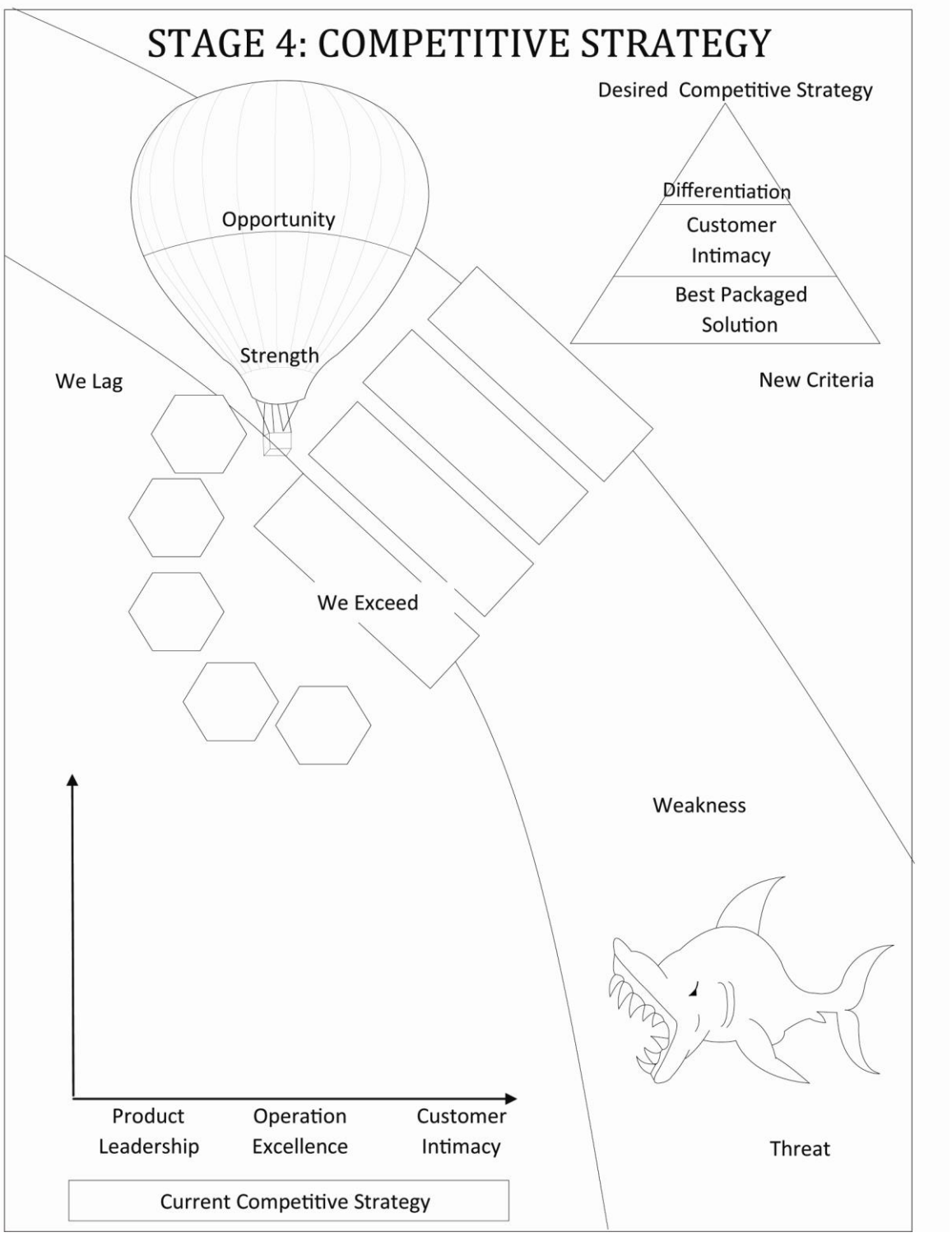


Figure 31: Facilitation Chart 4: Review Competitive Strategy

9.2.5 Facilitation Chart 5: PSS Competitiveness Measurement Chart

Facilitation Chart 5 is intended to assist the facilitator in kick starting the discussion of stage 5 of the PSSE workshop. The purpose of the PSS competitiveness chart is to assist the facilitator in guiding the participants through the discussion to identify elements that are critical to the performance of a PSS strategy and assess the competitiveness of each of the variables. The design of the facilitation chart is shown in Figure 32 and it contains the following topics for discussion:

- ***Quality*** – The quality of the product and services provided by the new PSS strategy. The designed new PSS must be able to deliver the promised functionality as well as conforming to the expectation of the customer's needs
- ***Cost*** - The cost of the PSS over the entire life cycle operation
- ***Flexibility*** – The flexibility of customisation the new PSS in the areas of product customisation, service customisation, variety of services and service contract
- ***Delivery*** – The responsiveness in delivering the new PSS
- ***Innovativeness*** – The innovativeness of the features of the new PSS
- ***Customer Loyalty*** - The loyalty level of customers number measured by using the 'No. of Returning Customers'
- ***Customer Satisfaction*** – The measurement of customer satisfaction in terms of 'Acceptance' and 'Willingness to Pay'
- ***Finance Performance*** - The financial performance of the new PSS in terms of 'Cash Flow', 'Turn Over', 'Profit' and 'Return of Investment'

COMPETITIVE ELEMENTS	VARIABLES	We Lag			We Match	We Exceed			Best Packaged Solution	Customer Intimacy	Differentiation
		-3	-2	-1	0	1	2	3			
Cost	Product Life Cycle										
	Service										
Quality	Conformance to Specification										
	Reliability										
Flexibility	Variety of Service										
	Service Recovery										
	Product Customisation										
Delivery	Responsiveness										
	Level of Product Customisation										
	Variety of Services										
Innovativeness	Product Feature										
	Service Feature										
Customer Loyalty	No. of Returned Customer										
Customer Satisfaction	Acceptance,										
	Willingness to pay										
Finance Result	Cash flow										
	Turnover										
	Profit										
	Return of Investment										
Marketing Performance	Market share										
	Market penetration										
	Brand Reputation										
TOTAL SCORE									36	9	21

Figure 32: Facilitation Chart 5: Assessment of PSS Competitive Elements

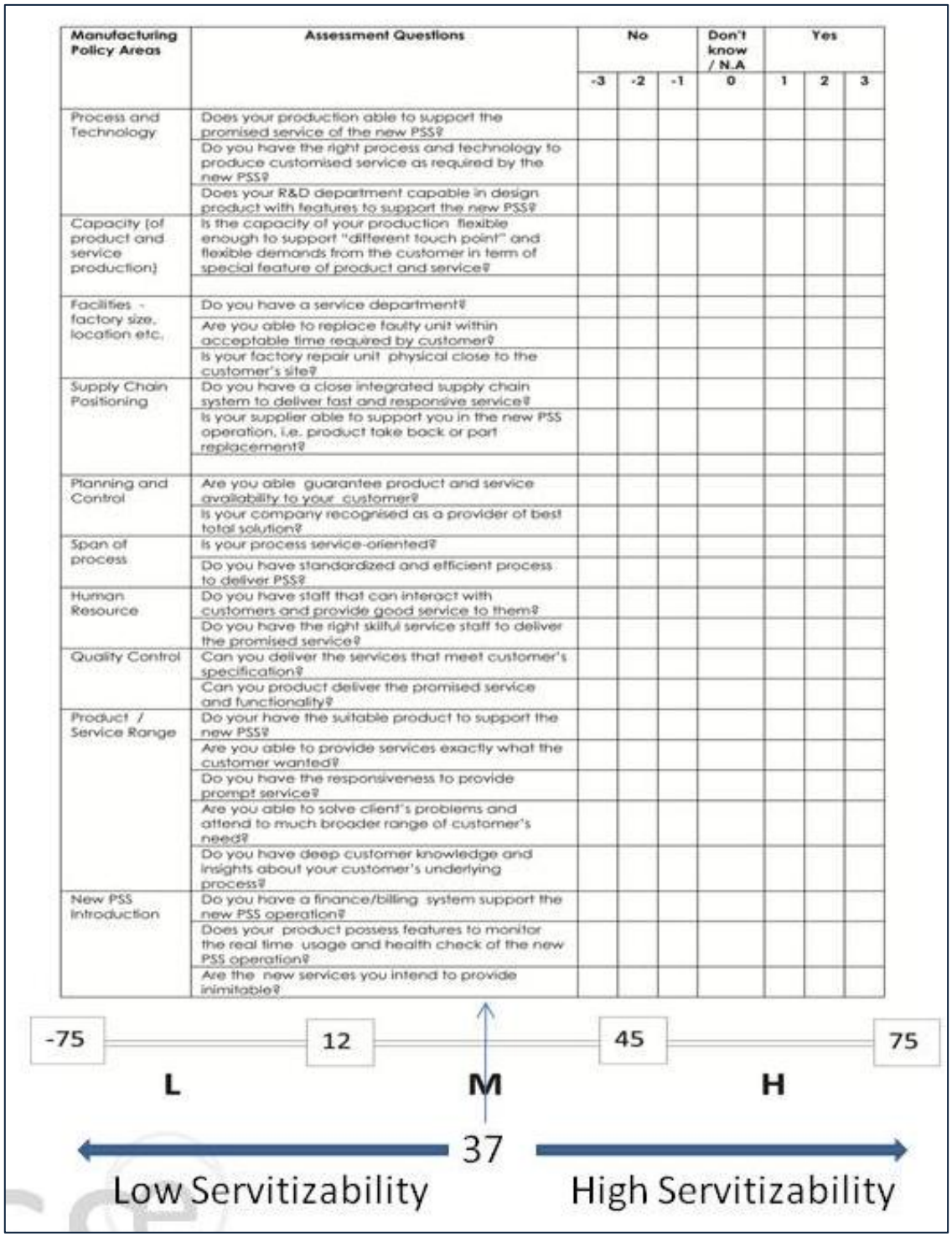
- ***Marketing Performance*** – The performance of the PSS in terms of 'Market Share', 'Market Penetration' and 'Brand Reputation'

Overall scores are generated for Best Packaged Solution, Customer Intimacy and Differentiation, which will then be used to compile the overall score of PSS competitiveness.

9.2.6 Facilitation Chart 6: Assessment of Servitizability of the Company

Facilitation Chart 6 is to be used in stage 6 of the PSSE workshop. The purpose is to allow the facilitator to lead the discussion with the participants to assess the Servitizability of the companies. This is carried out through the various manufacturing policies of the companies that are critical to support the delivery of PSS. The design of the facilitation chart is shown in Figure 33 and it contains the following topics for discussion:

- ***Process and Technology*** - The transformation processes and technologies, and most critically the way in which they are organised in order to deliver the new PSS
- ***Capacity*** - The maximum output of the factory
- **Facilities** - The factories size and location; and their focus in delivering the new PSS
- ***Supply Chain Positioning*** - Supply chain design to deliver the new PSS
- ***Planning and Control*** -Planning and control processes of service delivery in the new PSS
- ***Span of Process*** - The degree of vertical integration
- ***Human Resources*** - All the people-related factors, including human resources at both personal and organizational level



Manufacturing Policy Areas	Assessment Questions	No			Don't know / N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							
	Do you have the right process and technology to produce customised service as required by the new PSS?							
	Does your R&D department capable in design product with features to support the new PSS?							
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point" and flexible demands from the customer in term of special feature of product and service?							
Facilities - factory size, location etc.	Do you have a service department?							
	Are you able to replace faulty unit within acceptable time required by customer?							
	Is your factory repair unit physical close to the customer's site?							
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?							
	Is your supplier able to support you in the new PSS operation, i.e. product take back or part replacement?							
Planning and Control	Are you able guarantee product and service availability to your customer?							
	Is your company recognised as a provider of best total solution?							
Span of process	Is your process service-oriented?							
	Do you have standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide good service to them?							
	Do you have the right skilful service staff to deliver the promised service?							
Quality Control	Can you deliver the services that meet customer's specification?							
	Can you product deliver the promised service and functionality?							
Product / Service Range	Do your have the suitable product to support the new PSS?							
	Are you able to provide services exactly what the customer wanted?							
	Do you have the responsiveness to provide prompt service?							
	Are you able to solve client's problems and attend to much broader range of customer's need?							
	Do you have deep customer knowledge and insights about your customer's underlying process?							
New PSS Introduction	Do you have a finance/billing system support the new PSS operation?							
	Does your product possess features to monitor the real time usage and health check of the new PSS operation?							
	Are the new services you intend to provide inimitable?							

Figure 33: Facilitation Chart 6: PSS Servitizability Measurement Chart (PSS-SMC)

- ***Quality Control*** - The means ensuring products, services and people are operating according to the specification to fulfill customer's needs
- ***Product/Service Range*** – The range of existing products and services that can be used to deliver the new PSS
- ***New Product/Service*** **Introduction** - New products specifically designed to deliver the new PSS as well as new services created to deliver the new PSS

9.2.7 Facilitation Chart 7: PSS Competitiveness Measurement Matrix

Facilitation Chart 7 is to be used in stage 7 of the PSSE workshop, which is the final stage of the PSSE workshop. The purpose is to allow the facilitator to present to the participants the final outcome of the assessment of competitiveness of the new PSS strategy. The design of the facilitation chart is shown in Figure 34 and contains the following elements:

- ***Axis X - Competitiveness of PSS Elements -*** The X-axis of the facilitation chart, divides the level of PSS competitiveness into Low (<34) and High (>34)
- ***Axis Y – Servitizability of the Company –*** The Y-axis divides the level of the Servitizability of a company in the range of Low (<37) to High (>37)
- ***PSS Strategy Competitive Position –*** The competitiveness of the new PSS strategy is determined by the score of the PSS competitive element (X-axis) and the level of Servitizability (Y-axis). The final score will then put the new PSS strategy into one of the four categories, namely, '*Star PSS', 'Good PSS', 'Potential PSS' and 'Weak PSS'*

This section has described the seven new facilitation charts developed for the final PSSE methodology. The next Section will discuss the data collection protocol designed to execute and gather information for the secondary evaluation of the PSSE methodology which includes the evaluation of the set of facilitation charts described above.

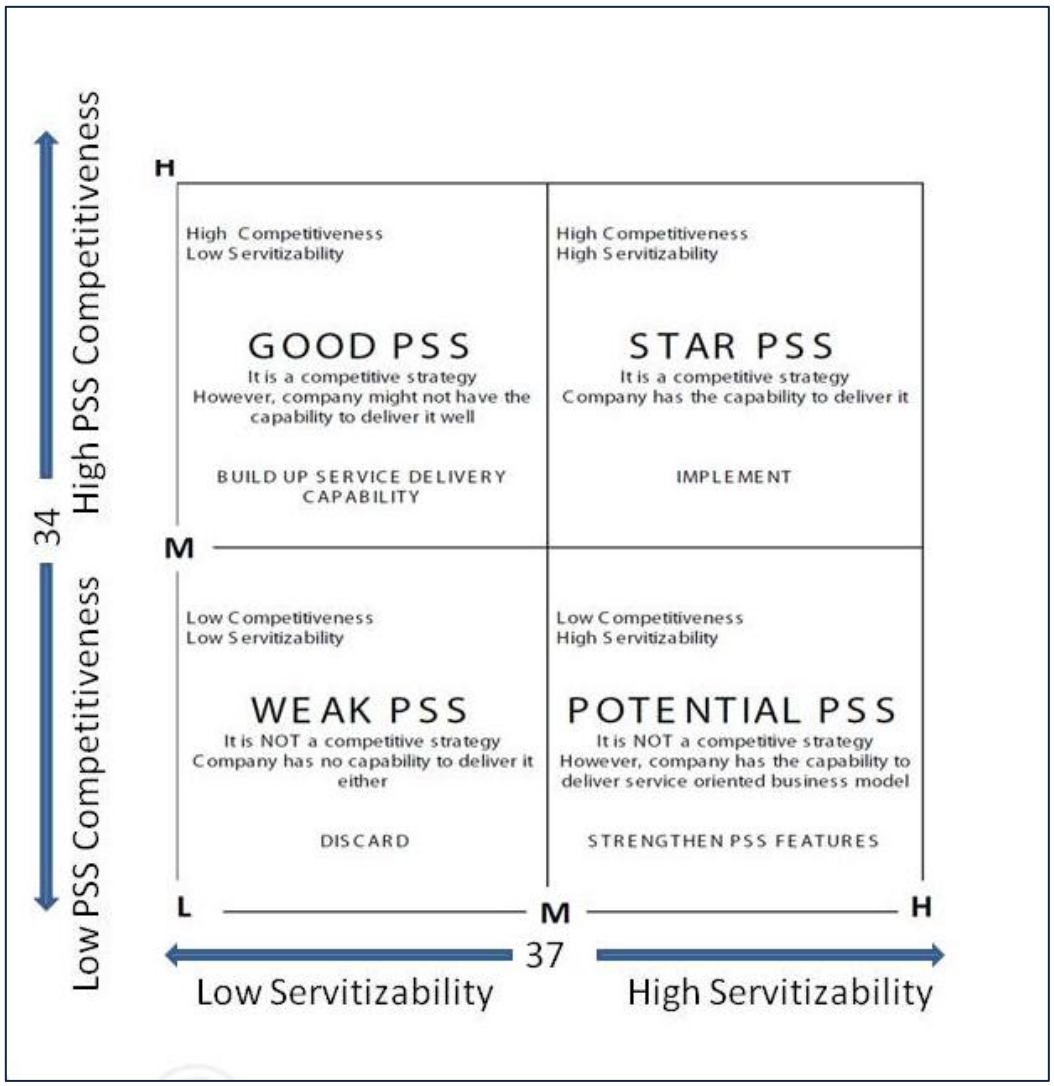


Figure 34: Facilitation Chart 7: PSS Competitiveness Assessment Matrix

9.3. DESIGN OF DATA COLLECTION PROTOCOL

9.3.1 Selection of Companies

This Section sets out to determine the selection criteria of the companies for the secondary evaluation. The strategy is to select four companies that fulfil the following criteria to take part in the secondary evaluation of the PSSE methodology:

- The company should be a product manufacturer
- The company must be providing services to support the products
- The company must have the intention to implement Servitization
- There is currently no methodology in place and a structured approach is needed for the assessment and design of the new PSS strategy.

The researcher used a three stage approach to select the companies. Firstly, companies with a profile that meets the criteria were selected from the ten companies that have participated in the industry interview in Chapter 5. Secondly, the researcher then followed this up by a phone call or email to brief the management of the potential companies with the structure of the PSSE methodology, the time required for the facilitated workshop and its expected outcomes. If the company decided to go ahead with the PSSE workshop, the final stage involved presenting the methodology to the management team and discussing the possibility of training one of the project team members as a facilitator, and finally leads to selecting suitable date and project team for the workshop.

9.3.2 Establishment of the Data Collection Method

The methods used to collect data are described in this Section. As the researcher is acting as an observer come participant, according to Gill

and Johnson (1997), the researcher may have to rely upon the facilitators to provide feedback on events that the researcher failed to observe. Thus, during the secondary evaluation data was gathered through various research instruments from the facilitator, namely: face to face meeting, email discussion and post workshop assessment questionnaires.

The assessment criteria used in assessing the PSSE methodology during the secondary evaluation are similar to the criteria used in the primary evaluation which was described in Section 8.2. In short, three requirements, namely, feasibility, usability and usefulness of the PSSE methodology, will be assessed by using the same set of questions which can be found in Appendix A.

Table 36: Profile of the Selected Companies for the Secondary Evaluation of the Pilot PSSE Methodology

	Case S1: Partial Discharge Co.	**Case S2: Beauty Machine Co.**	**Case S3: Hydro and Thermal Co.**	**Case S4: Semi-Con Equipment Co.**
Range of Products	Partial Discharge Analyser	Hair Care and Beauty Machines	Ionic Water Heater	Wafer inspection machine
Range of current services	Warranty, repair & training	Warranty, Repair, Training, Marketing support	Warranty, Repair, Training, Marketing support	Warranty, repair & training
Current Business Focus	One stop service providers for testing of power, partial discharge and vibration etc.	Contract manufacturing, own brand equipment	Manufacturing and distribution of water heater	Contract manufacturing and equipment manufacturer for semi-conductor industry
Main Contact Point	Managing Director	Managing Director	Founder	Managing Director
Location of Manufacturing Facilities	Singapore	Singapore	Singapore and Malaysia	Singapore
Number of Employee	20-30	100	<10	300

9.4. EXECUTION OF SECONDARY EVALUATION

This Section provides a brief introduction of the four companies who participated in the secondary evaluation of the PSSE methodology. Table 36 shows the profile of the selected companies. The preparation, testing and evaluation process that took place between June 2009 and April of 2010.

9.4.1 Case S1: Partial Discharge Analyser Co.

Discharge Analyser Co. is an innovative research based company that specializes in developing new and reliable electrical technologies in the area of partial discharge inspection and testing. It provides an inspection service using Infrared Thermograph technology. They have a strong client base of more than 50 customers from Singapore, Malaysia and China using their services.

9.4.2 Case S2: Beauty Machine Co.

Beauty Machine Co. designs and manufactures its own range of hair care products such as hair dryers, hair irons, mist and steaming machines, as well as accessories such as hair clips etc. aimed at salons and end consumers. The company has manufacturing plants in Malaysia and China. In addition to manufacturing and selling hair care products It also provide sourcing services to foreign companies outside Singapore to buy or sell hair care products in and out of China.

9.4.3 Case S3: Hydro and Thermal Co.

Hydro and Thermal Co. is a new start-up company focussed on manufacturing and distributing ionic water heaters. The founder of this company is an ex-staff of Case P1. The company intends to manufacture and distribute ionic instant water heater and a range of consumer

electronic white goods targeted at the South East Asia market. The company also has the intention to distribute medical devices in the future. The PSS discussed during the PSSE workshop is a simple 'Product Oriented PSS' with a list of services designed to support the sales of the new ionic instant water heater.

9.4.4 Case S4: Semi-con Equipment Co.

Semi-con Equipment Co. provides assembly of printed circuit board, manufacturing and equipment design services. It currently provides value-added services such as circuit layout, materials management, prototyping and development engineering in the industrial equipment market. The company has built its own brand of semi-conductor equipment in water inspection and manufactures machines that are built to customer bespoke specifications. The company business concept has been moving from 'Product Oriented PSS', to 'Use Oriented PSS' and is currently exploring developing products to cater for 'Result Oriented PSS'.

A detailed description of the PSS case study generated by the four case studies can be found in Appendix C.

This Section has given a brief introduction to the background of the case studies. The post assessment results of the secondary evaluation of the PSSE methodology using the above mentioned four case studies will be presented and analysed in the next Section.

9.5. RESULTS OF THE SECONDARY EVALUATION OF THE PSSE METHODOLOGY

This Section presents the analysis of the results of the execution of the four case studies using the post PSSE workshop assessment questionnaires provided in Appendix D-1. Similar to the primary evaluation, the assessment was conducted using quantitative questions which were designed using a 5 point scale, i.e. 5 being Yes, 4 being Mostly, 3 being Don't know, 2 being Partly and 1 being not at all. A score of zero indicates no answer was given. In order to be consistent in computing the result with the primary evaluation, the total percentage for each of the criteria is calculated using the average sum for each criterion divided by the total number of the participants who had taken part in the post assessment exercise.

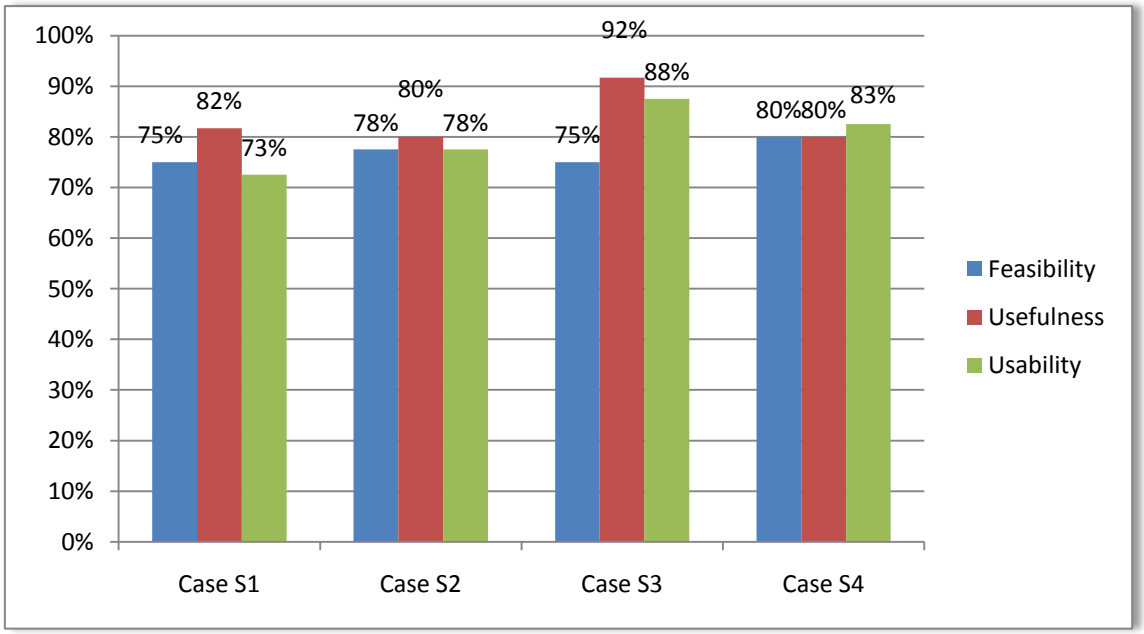


Figure 35: Score of the Results of the Secondary Evaluation of PSSE Methodology

9.5.1 Feasibility of the Refined PSSE Methodology

The first part of the secondary evaluation is to assess whether the PSSE methodology is feasible using performance indicators such as Consistency, Completeness, Contingency and Applicability as indicated in the questionnaires provided in Appendix D-1. As shown in Figure 34, the average score is 75% for Case S1, 78% for Case S2, 70% for Case S3, and 80% for Case S4. The average score of the feasibility of the four participating companies is 75.63% and the results is shown in Table 37.

Table 37: Assessment Results of the Feasibility Evaluation of the refined PSSE Methodology

Feasibility Criteria	Case S1	Case S2	Case S3	Case S4	Average Overall Score
Consistency	4.5	4.5	4.0	5.0	4.5
Completeness	3.5	3.5	4.0	3.5	3.6
Contingency	3.5	4.0	3.5	4.0	3.8
Applicability	3.5	3.5	3.5	3.5	3.5
					76.88%

The above average score demonstrates that the methodology can be followed successfully. The detailed result of the feasibility assessment can be found in Appendix D3. Following are some of the comments extracted from Q1.5 of the questionnaires which support the findings:

- Case S1-Q1.5 - "It is rather easy to follow through the various stages of the methodology. The facilitation chart is good in giving us a good picture of what we have discussed"
- Case S2- Q1.5 – "I think it is a good methodology. Easy to use"

In addition, all the facilitators have given an overall rating of "Very Good" for the feasibility of the methodology.

9.5.2 Usefulness of the Refined PSSE Methodology

The second part of the primary evaluation is to assess whether the PSSE methodology is useful using performance indicators such as 'Effectiveness', 'Contribution', 'Efficiency', 'Practicality', 'Success' and 'Satisfaction'. As shown in Figure 35, the average score is 82% for Case S1, 80% for Case S2, 77% for Case S3, and 80% for Case S4. The average score for the feasibility of the four participating companies is 75.63% and the result is shown in Table 38.

Table 38: Assessment Results of the Usefulness Evaluation of the refined PSSE Methodology

Usefulness Criteria	Case S1	Case S2	Case S3	Case S4	Average Score
Effectiveness	5.0	5.0	4.0	5.0	4.8
Contribution	3.5	3.5	5.0	3.5	3.9
Efficiency	4.5	4.0	5.0	4.0	4.4
Practicality	4.5	4.5	4.0	3.5	4.1
Usefulness	3.5	3.5	4.5	3.5	3.8
Satisfaction	3.5	3.5	5.0	4.5	4.1
					83.33%

The above average score demonstrates that the methodology is useful and able to deliver the expected results, although feedback from Case S2 displayed a need to improve the facilitation process. Following are some of the comments extracted from Q2.7 of the questionnaires which support the findings:

- Case S1-Q2.7 - "The PSSE methodology is a useful methodology, it is practical and able to give useful expected results"
- Case S3-Q2.7 - "Useful in assessing a company's strength and weaknesses"

- Case S4- Q2.7 – "Rather satisfied with the result achieved. However, would like to see more improvement in term of the facilitation process"

The detailed results of the feasibility assessment can be found in Appendix D3.

9.5.3 Usability of the Refined PSSE Methodology

The third part of the secondary evaluation is to assess whether the refined PSSE methodology is usable through the use of performance indicators such as 'Ease of Use', 'Time', 'Understanding' and 'Flexibility'. As shown in Figure 34, the average score is 73% for Case S1, 78% for Case S2, 75% for Case S3, and 83% for Case S4. The average score for the feasibility of the four participating companies is 75.63% and the result is shown in Table 39.

Table 39: Assessment Results of the Usability Evaluation of the refined PSSE Methodology

Usability Criteria	Case S1	Case S2	Case S3	Case S4	Average Score
Ease of Use	3.5	3.5	4.0	4.0	3.8
Time	4.5	4.5	4.5	4.5	4.5
Understanding	3.0	4.0	4.5	4.0	3.9
Flexibility	3.5	3.5	4.5	4.0	3.9
					80.00%

The above average score demonstrates that the methodology is fully usable and can be followed with ease. Following are some of the comments extracted from Q3.5 of the questionnaires which support the findings:

- Case S1-Q3.5 - "The methodology is rather useful"
- Case S2-Q3.5 – "The design of the competitive strategy assessment worksheet can be simplified"

- Case S3-Q3.5 – "The workbook should provide more references & definitions on the terms used"
- Case S3-Q3.5 – "User friendly and self explanatory worksheets"

The detailed results of the usability assessment can be found in Appendix D3.

9.5.4 Overall Performance of the Refined PSSE Methodology

In measuring the overall success of the methodology, the facilitators rated the PSSE methodology success as 4, 3, 3 and 4 respectively. The following statements support the findings.

- ✓ "Useful methodology for companies who want to diversify its business to selling PSS" (Case S1)
- ✓ "Successful, worth doing" (Case S2)
- ✓ "Need to add in page number of the PSSE workbooks and to commercialize it if possible" (Case S3)
- ✓ "Good methodology, the facilitator chart is rather useful in helping to consolidate discussion" (Case S4)

Following are the comments: regarding to whether they will use the methodology in the future:

- ✓ "Yes, would like to use it if possible" (Case S1)
- ✓ "N.A" (Case S2)
- ✓ "Yes" (Case S3)
- ✓ "Yes, however, some changes might need to be made to cover the sustainability assessment of the PSS strategy, as to my understanding, this is one of the important elements of PSS" (Case S4)

The secondary evaluation was delivered by different facilitators with different skill sets, and the above comments and results have demonstrated that the methodology has successfully delivered its expected outcomes.

9.6. ANALYSIS OF CROSS-CASE RESULTS

9.6.1. Summary of PSS Competitive Strategy Produced in the PSSE Workshop

This Section presents the results of the cross case analysis of the primary and secondary evaluation of the PSSE methodology against the established assessment criteria with the six participating companies. The pilot version was tested in the primary evaluation using Cases P1 & P2 whereas the refined version was tested in the secondary evolution using Cases S1, S2, S3 and S4. The results of the PSS competitive strategies generated in the six case studies are provided in Figure 36 and Table 40.

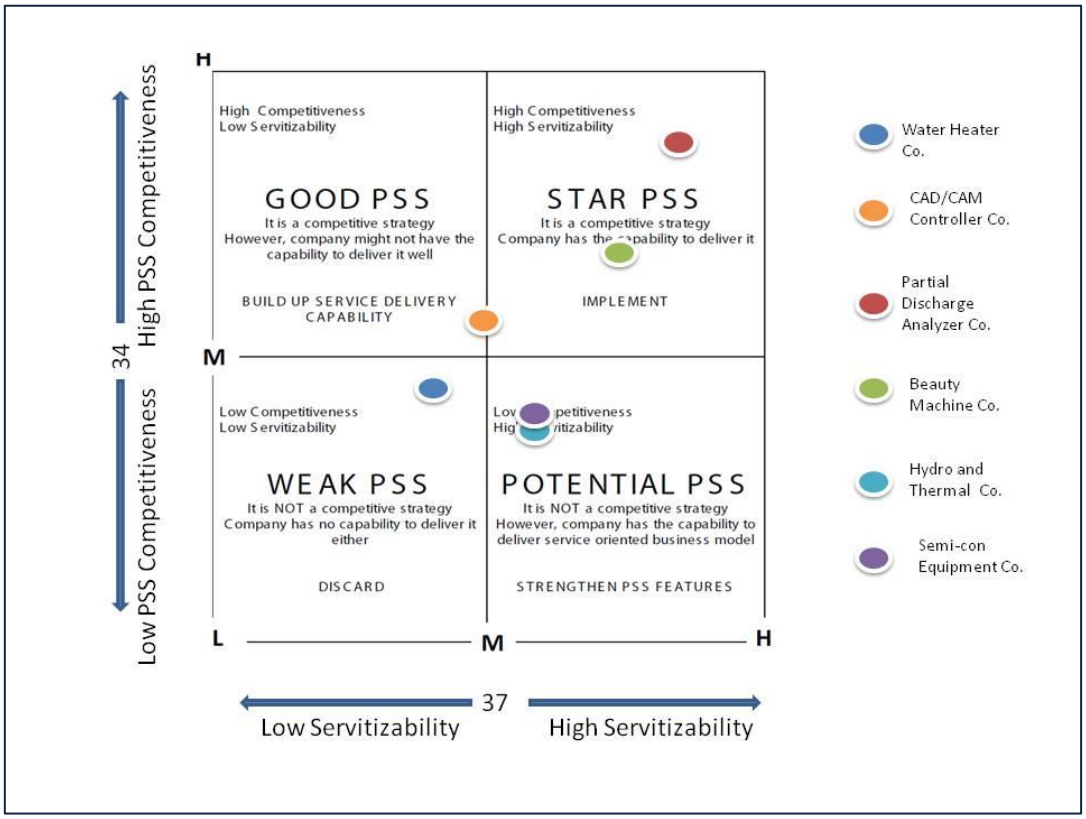


Figure 36: Summary of PSS Competitive Strategies Produced in the Primary and Secondary Evaluation

As shown in Figure 36, The PSSE methodology has generated two 'STAR-PSS', one 'GOOD-PSS', two 'POTENTIAL-PSS' and one 'WEAK-PSS' strategies from the six participating companies during the primary and secondary evaluation of the PSSE methodology.

Case Study	PS S Competitive Elements	Level of Servitizability	PSS Model Identified	PSS Strategy
P1: Water Heater Co.	Low	Low	✓ Product Oriented PSS	Weak PSS
P2: CAD/CAM Controller Co.	High	Low	✓ Product Oriented PSS	Good PSS
S1: Partial Discharge Analyser Co.	High	High	✓ Product Oriented PSS ✓ Result Oriented PSS	Star PSS
S2: Beauty Machine Co.	High	High	✓ Use Oriented PSS ✓ Result Oriented PSS	Star PSS
S3: Hydro and Thermal Co.	Low	High	✓ Result Oriented PSS	Potential PSS
S4: Semi con Equipment Co.	Low	High	✓ Result Oriented PSS	Potential PSS

Table 40: Summary of PSS Competitive Strategies Produced in the Primary and Secondary Evaluation

9.6.2. Summary of PSSE Methodology Assessment Results

The evaluation procedure tested the PSSE methodology against the assessment criteria of *Feasibility, Usability and Usefulness* and has demonstrated its feasibility, usefulness and usability:

Feasibility: The methodology is feasible and has been used consistently across the six case studies and has generated an average score of 71% for the six cases.

Usability: The provisions of the PSSE Facilitator's Guide, worksheets and facilitation charts, made the methodology relatively easy to use in a facilitated workshop, and allow the companies to capture the results discussed and stimulate learning. The six cases have generated an average score of 75% for usability.

Usefulness: All companies were satisfied with the results achieved. The average score of this category is 78%.

Generally the average score is higher than 60% which demonstrates that the PSSE methodology is feasible, useful and usable. Summaries of the comments and observations from the researchers and facilitators resulted from the PSSE workshops are provided in Table 41 and 42.

Table 41: Cross-case Findings of the Primary and Secondary Evaluation of PSSE Methodology

	Case P1 – Water Heater	Case P2 – CADCAM Controller	Case S1 – Partial Discharge Analyser	Case S2 – Beauty Equipment	Case S3 – RFID Sensors	Case S4 – Semicon Equipment
Version of Methodology	Pilot	Pilot	Refined	Refined	Final	Final
Workshop facilitated by	Researcher	Researcher	Certified Facilitator	Marketing Manager of the Participating Company	Untrained Facilitator	Certified Facilitator (repeated)
Role of Researcher	Facilitator	Facilitator	Assistant Facilitator	Assistant Facilitator	Participant /Observant	Participant /Observant
Participant	Marketing Director Operation Manager Quality Engineer	Managing Director Software Engineer	Managing Director Testing Engineer	Managing Director Sales Director Technical Manager	Managing Director Technical Director Sales Manager Product Designer	Chief Technical Officer System Engineer Sales Manager
Result of Practicability Evaluation						
Feasibility	61.7%	75.0%	75.0%	77.5%	71.7%	80.0%
Usability	71.7%	70.0%	71.7%	77.5%	76.7%	82.5%
Usefulness	68.9%	75.0%	78.9%	80.0%	75.0%	80.0%
Summary of Major Feedbacks Used in Improving the Methodology						
Overall Structure & Flow of Workshop		Overall structure can be more precisely defined		-		-
Tools & Techniques	To include more structured chart to facilitate the overall flow		New form for Critical Success Factor Discussion	Should include tool for evaluation of the sustainability and eco foot print of the new PSS	Too many questions in the competitive strategy worksheet, and most of them are repetitive	To include extra column in Worksheet 2.1 for description of service operation
Improvement based on feedback from participating companies	Graphic Facilitation Chart Introduced	Expansion of overall structure from 6 to 7	Introduce new form for Critical Success Factor Discussion	No action taken as this aspect is not within the current scope of research	-	Refined the design of Worksheet 2.1 to include the column for describing services operation
Improvement based on researcher's observations		Reorganisation of steps for the new stages 3 and 4		Refined the design of facilitator chart 2.1 for stage 2	Simplified the design of post workshop evaluation form, A1 to A3	

Table 42: Summary of Comments and Observation from Facilitators

Execution of the Facilitated PSSE Workshop	
Organisation of the workshop	✓ The PSSE workshops have been considered to be successful, as companies who have participated throughout the entire workshop actively participated in the discussion and provided feedback on the improvement of the final methodology ✓ Apart from Case S4, who cancelled the appointments and delayed the workshops a couple of times due to busy schedules, most companies were able to start the workshop as planned ✓ All teams participated through the entire workshop
Overall Discussion of PSS Strategy	✓ All companies participated actively in discussing their new PSS cases, however PSS strategies discussed tended to be not too complex due to time constraints ✓ Able to generate the desired outcomes by producing expected outcomes
Tools and Techniques	
Usage of Worksheets	✓ Purpose of worksheets was achieved as lots of information and feedbacks were collected at the end of the evaluation workshop ✓ Some of the worksheets are not too easy to use, for example, the PSS competitiveness and Servitizability measurement charts of stage 5 and 6.
General comments on the Facilitation Chart	✓ Good ✓ Effective in providing an overall picture of the entire PSSE workshop ✓ Make the entire facilitation process a lot easier
Feedback on End Reports Generated	✓ Clear and precise ✓ Provide sufficient information to the companies for future decision making ✓ Companies were happy to receive the report at the end of the workshop
Facilitator Guide	
Instruction and Content	✓ The guide is clear and easy to follow, however need improvement in the final format as it is rather simple in design ✓ Facilitation chart is simple and did a good job in guiding the flow of discussion and provided the participants with a clearer picture of the topics being discussed
Overall Remarks	
Overall Expectation and Comments	✓ The PSSE methodology is able to deliver the intended results. ✓ The overall methodology is structured, procedural and with lots of useful tools and techniques to support the execution ✓ Design of steps and worksheets provided are generally good ✓ Most participants are likely to use the methodology for future professional consultancy work or to produce an actual PSS strategy

9.7. THE STRUCTURE OF THE FINAL PSSE METHODOLOGY

9.7.1 The 7 Stages of the PSSE Methodology

The final PSSE methodology is a 7-stage methodology as shown in Figure 37. The detailed description of the final PSSE methodology can be found in Appendix B.

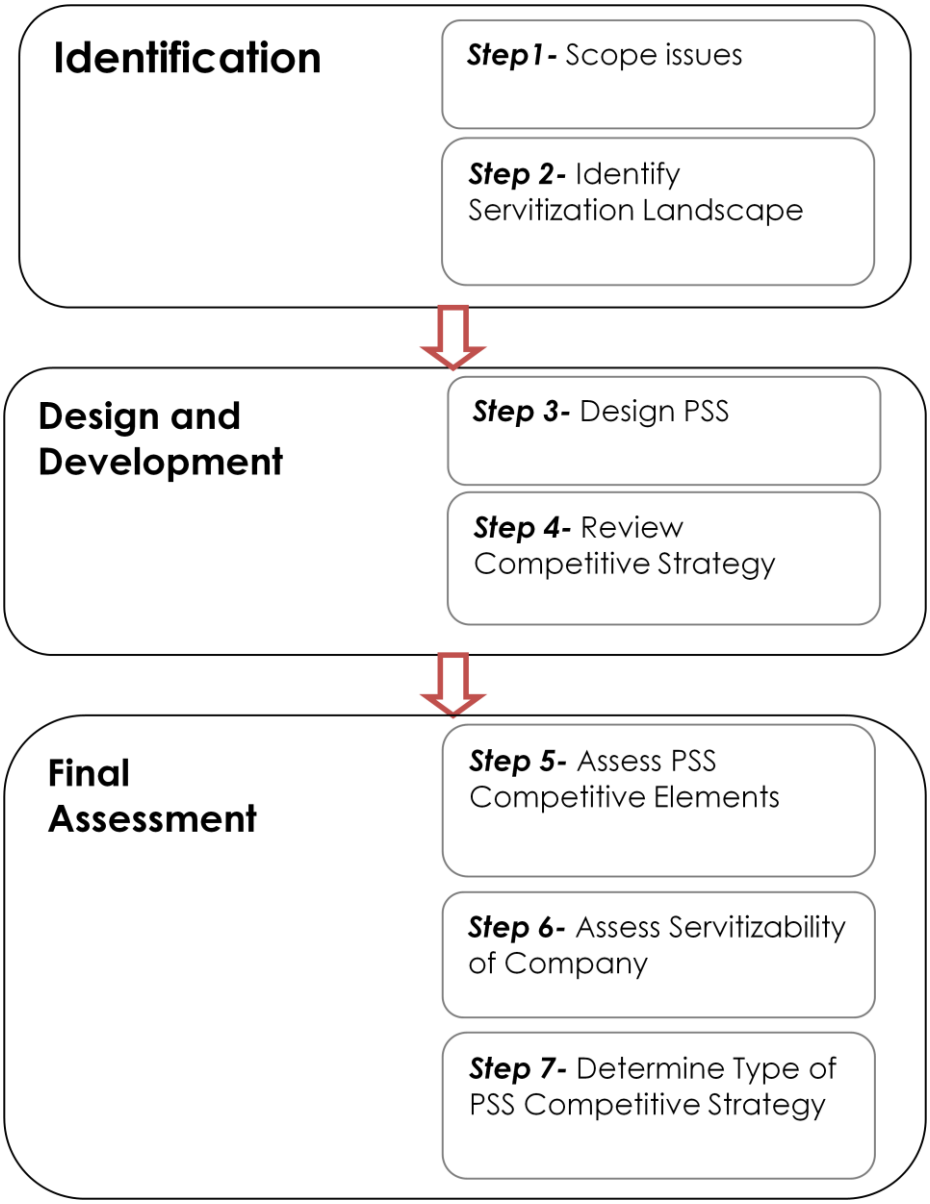


Figure 37: The Structure of the Final PSSE Methodology

Stage 1: Scope Issues

The first stage of the PSSE methodology consists of steps that are designed to identify core competency of the company, reasons for Servitization, overriding problems and challenges. The intention of stage 1 is to guide the participants in understanding their current situation and the desire of moving towards adopting a new strategy. Stage 1 of the PSSE methodology also explores the potential range of products that can be used in the new PSS strategy. At the end of this stage, a Servitization task force team will be formed in order to continue working on identifying the Servitization landscape in Stage 2 and designing the new PSS activities in Stage 3.

Stage 2: Identify Servitization Landscape

The second stage of the PSSE methodology focuses on discussing issues related to the customer needs. During this stage, the focus is on the product features that can be used to fulfil the needs of the customers, the drivers and barriers towards Servitization, and the list of current and new services for the new PSS strategy will be discussed. This stage of the PSSE methodology also helps the company in classifying the types of new PSS strategy into a 'Product Oriented PSS', 'Use Oriented PSS' or 'Service Oriented PSS'.

Stage 3: Design PSS

The third stage of the PSSE methodology consists of steps mainly to work on the operation and service delivery system of the new PSS strategy. It involves reviewing the current activities of the company as well as working on the new activities that are required to deliver the new PSS strategy. During this stage, the critical resources that are required to support the new PSS activities can also be discussed.

Stage 4: Review Competitive Strategy

The forth stage of the PSSE methodology consists of steps to review the current competitive strategy of the company. It helps to identify whether the current competitive strategy is based on 'Product Leadership', 'Customer Intimacy or 'Operation Excellence'. During this stage, a 'SWOT' analysis will be conducted to gain a better understanding of the company's industrial competitive position and the critical success factor that is crucial in delivering the new PSS strategy can be discussed.

Stage 5: Assess PSS Competitive Elements

The fifth stage of the PSSE methodology consists of steps to assess the competitiveness of the PSS elements. It assesses the competiveness of the three PSS competitive dimensions, '*Best Packaged Solution', 'Customer Intimacy' and 'Differentiation'* of the proposed PSS strategy. This stage makes use of the 'PSS Competitive Element Measurement Chart '(PSS-CMC) to produce the results of 'PSS Competitiveness' by asking the participants to go through a list of 22 questions in the three competitive dimensions. The participants will be asked to give a score of -3 to 3 to each of the questions and competitiveness of the PSS elements will be rated as low, if the final score is below 34 and high if the final score is above 34.

Stage 6: Assess Servitizability of Company

The sixth stage of the PSSE methodology assesses the level of Servitizability of the company in term of its structure and infra-structure policy areas. The purpose is to determine whether the company possesses the right capability to deliver the new PSS strategy both structurally and infra-structurally. This stage makes use of the 'PSS Servitizability Measurement Chart' (PSS-SMC) to generate the results of the Servitizability of the company by asking the participants to go

through a list of 25 questions in order, in the areas of structure and infra-structure policy areas. The participants will then be asked to give a score of -3 to 3 to each of the questions; This will allow Servitizability of the company to be rated as low, if the final score is below 37 and high if the final score is above 37.

Stage 7: Determine Type of PSS Competitive Strategy

The last stage of the PSSE methodology consolidates the outcomes and assesses the competitiveness of the new PSS strategy by using the 'PSS Competitiveness Assessment Matrix' (PSS-CAM). The final result is produced by placing the score of the 'PSS Competitive Dimensions' and the 'Servitizability' on the matrix. The assessment matrix will allow the determination of the new PSS strategy as a *'STAR PSS', 'GOOD PSS', 'POTENTIAL PSS' or a 'WEAK PSS'*. The final score in this stage will then provide summarised information about the type of PSS strategy, Level of PSS element competitiveness, level of Servitizability, critical resources required to deliver the new PSS activities and future actions.

Table 43-44 provide a summary of the steps, expected outcomes, worksheets and facilitation charts that are required to conduct a PSSE workshop using the PSSE methodology.

9.7.2 The PSSE Facilitator's Guide

The targeted users of the PSSE Facilitator's Guide are facilitators who want to conduct the PSSE workshop, using the newly developed PSSE methodology. The facilitator can be an external professional, someone who will be using the PSSE methodology to provide consultancy or a member of the project team from the participating company. The PSSE Facilitator's Guide has the following objectives:

- To assist the facilitator in delivering the expected outcomes of the PSSE methodology
- To support the facilitation of the PSSE workshop
- To provide clear description of the PSSE methodology and instructions in conducting the stages of the PSSE methodology
- To provide templates of the facilitation charts and worksheets that will be used in the PSSE workshop

The PSSE Facilitator's Guide consists of the following structure:

- Part 1: Facilitator's Information
- Part 2: The PSSE Methodology
- Part 3: PSSE Presentation Slides
- Part 4: PSSE Facilitation Charts
- Part5: PSSE Worksheets
- Part6: References

The cover page of the PSSE Facilitator's Guide is shown in Figure 38 and a copy of the PSSE Facilitator's Guide is presented in Appendix B.

Figure 38: The PSSE Methodology Facilitator's Guide

9.8. CHAPTER SUMMARY

This chapter has discussed the newly developed facilitation charts that are aimed at making the PSSE methodology more feasible, usable, and useful when delivered via a facilitated workshop. The results of the second evaluation of the four different case studies, as well as results of cross-cases between the first and secondary evaluation of the PSSE methodology were reported and analysed. The refined PSSE methodology in the secondary evaluation was judged to be feasible, usable and useful by the participating companies. This chapter has also presented the structure of the final PSSE methodology and areas for further refinement. The final PSSE methodology is structured, procedural and descriptive. The next chapter will conclude the research programme, make contributions to knowledge and recommend future research in the field.

Table 43: Overview of Activities and Output of the PSSE Methodology

	Step1: Scope Issue	Step 2: Identify Servitization Landscape	Step 3: Design PSS	Step 4: Review Competitive Strategy	Step 5: Assess PSS Competitive Elements	Step 6: Assess Servitizability of Company	Step 7: Determine Type of PSS Competitive Strategy
Steps	Step 1: Identify core competency of the company Step 2: Discuss reasons for Servitization Step 3: Discuss overriding problems and challenges Step 4: Identify products to be used for the new PSS competitive strategy Step 5: Identify role for the project team	Step 1: Understand Customer Needs Step 2: Identify Drivers and Barriers towards Servitization Step 3: Brainstorm on new services for PSS Step 4: Identify the new PSS model	Step 1: Identify activities related to the delivery of the new PSS Step 2: Identify features of the products to support the new PSS Step 3: Identify Critical Resources for the new PSS activities Step 4: Identify services that support both the products and customers Step 5: Identify targeted market	Step 1: Perform SWOT Analysis Step 2: Review current competitive strategy Step 3: Identify critical success factor in delivering the new PSS strategy Step 4: Discuss the desired competitive strategic position of the new PSS strategy	Step 1: Discuss the PSS competitive dimensions and its variables Step 2: Generate overall score of the competitive dimensions	Step 1: Discuss the Servitizability of the company Step 2: Generate overall score of the Servitizability of the company	Step 1: Discuss the results produced in stage 5 and 6 of the PSSE workshop Step 2: Determine the type of the new PSS competitive strategy Step 3: Discuss future actions
Output	*Issue Statement and Servitization Task Force*	Servitization Landscape	PSS Activities	Desired PSS Competitive Strategy	*PSS Element Competitiveness Score*	Servitizability Score	*Final PSS Competitiveness Score Card and Future Plan*

Table 44: Overview of Worksheets and Facilitation Charts of the PSSE Methodology

	Step1: Scope Issues	Step 2: Identify Servitization Landscape	Step 3: Design PSS	Step 4: Review Competitive Strategy	Step 5: Assess PSS Competitive Elements	Step 6: Assess Servitizability of Company	Step 7: Determine Type of PSS Competitive Strategy
Worksheet	1.1: Servitization Task Force Members	2.1: Understanding Customer's Needs 2.2: Potential PSS Services	3.1: Design New Activities for PSS 3.2: Identify Critical Resources for New PSS 3.3: Identify Critical Success Factors	4.1: SWOT Analysis 4.2: Review Current Competitive Strategy 4.3: Score Card for Competitive Strategy Review	5.1 – PSS Competitive Elements Measurement Chart (PSS-CMC)	6.1 – PSS Servitizability Measurement Chart (PSS-SMC)	7.1 – PSS Report Card and Future Plans
Facilitation Chart	Facilitation Chart 1– Scope issues	Facilitation Chart 2 – Servitization Landscape	Facilitation Chart 3 – Design PSS	Facilitation Chart 4– Review Competitive Strategy	Facilitation Chart 5– PSS Competitive Elements Measurement Chart (PSS-CMC)	Facilitation Chart 6 – PSS Servitizability Measurement Chart (PSS-SMC)	Facilitation Chart 7 – PSS Competitiveness Measurement Matrix (PSS-CAM)

CHAPTER 10: CONCLUSIONS

The aim of this research is to develop a practical, useful and effective methodology that would assist the manufacturing companies in assessing whether the adoption of a PSS is a good competitive strategy. This chapter summarises the research contributions, limitations and future directions of this research. Section 10.1 first provides an overview of the research aim and the structure of the research programme. The primary and secondary research contributions are then presented in Section 10.2. Section 10.3 discusses the limitations of the research and the directions for future work are proposed in Section 10.4. The final remarks of the conclusions of this research are provided in Section 10.5.

10.1. OVERVIEW OF RESEARCH AIM AND PROGRAMME

The aim of this research was defined in Section 4.2:

> *"to design and evaluate a methodology that will enable manufacturing companies in Singapore to assess whether the adoption of PSS is a competitive strategy"*

The research aim was achieved by completing the following five research objectives which were defined in Section 4.2:

1. Identification of the requirements set for the PSSE methodology
2. Selection of the existing methodologies against the established requirements set

3. Development of the pilot PSSE methodology

4. Primary Evaluation of the pilot PSSE methodology using industrial applications with the researcher acting as the facilitator

5. Secondary evaluation of the refined PSSE methodology using industrial applications with independently trained and untrained facilitators and the development of the final methodology

A 5-phase research programme, with carefully chosen research methods to deliver the research objectives, was developed (Section 4.4), and has been successfully executed to deliver the research objectives systematically.

Phase 1: The first phase of the research programme was designed to establish the requirements set for the PSSE methodology. It started by reviewing literature to gain a good understanding of the characteristics that would be used to form a good and practical methodology. A data collection protocol was designed to collect data from the industry concerning the preferred delivery mechanism and content of the PSSE methodology by using survey with data collected using semi-structured interviews. A set of final requirements that can be used to provide guidelines in the development of the PSSE methodology was successfully generated at the end of this stage. The details of the execution of this phase were described in Chapter 5.

Phase 2: The second phase of the research programme was formulated to evaluate and select potential methodologies from the literature to form the conceptual base for the development of the new PSSE methodology. The methodologies were selected using the requirements established in the first phase of the research programme. In total, three

methodologies were eventually selected from existing literature, out of which two were from the category of manufacturing methodology and one from the category of PSS. The execution of this phase was described in Chapter 6.

Phase 3: The third phase of the research programme was designed to formulate the structure of the pilot PSSE methodology. The main research efforts in this phase were the development of the framework for a PSS competitive strategy, the new 'PSS Competitive Measurement Chart' and the 'PSS Servitizability Assessment Chart'. The outcome of the third phase of the research programme is the development of the pilot PSSE methodology. The execution of this phase was described in Chapter 7.

Phase 4: The fourth phase of the research programme was set out to execute the primary evaluation of the pilot PSSE methodology using two industrial cases; with the researcher acting as the facilitator. The usefulness, feasibility and usability of the pilot methodology were evaluated. As shown in Figure 25, the participating companies gave an average score of higher than 60% and generally regarded the PSSE methodology as a useful, usable and feasible.

The main refinement of this stage was the development of a set of new facilitation charts based on the feedback of the primary evaluation. Other feedback solicited includes removing non-critical steps, adding in a new stage and simplifying the worksheets etc. The final outcome of this stage was a refined PSSE methodology which was an improvement from the pilot version, and included an additional stage for assessing the Servitizability of the company, and a new set of facilitation charts designed for making it more effective in use via a facilitated workshop. The refined PSS methodology consists of seven clearly defined stages and its description was provided in Chapter 8.

Phase 5: The last phase of the research programme was designed to evaluate the refined PSSE methodology in four industrial applications using independently trained and untrained facilitators. The methodology was evaluated using similar sets of assessment criteria to those used in the primary evaluation. The role of the researcher during the secondary evaluation was to act as the participant come observant, and to intervene as little as possible throughout the entire workshop. And overall companies were generally satisfied with the outcomes of the PSSE methodology. As shown in Figure 35, all participating companies gave an average score of higher than 70% demonstrating the secondary evaluation of the refined PSSE methodology to be successful.

The post assessment of the primary and secondary evaluation reuslts of the PSSE workshop are provided in Appendix D. The results led to some minor modifications being made to the refined PSSE methodology after the secondary evaluation, i.e. improvement of the facilitation chart of stage 3. To summarise, the outcome of the 5-phase research programme was the final PSSE methodology which is presented in the form of a Facilitator's Guide as presented in Appendix B.

10.2. PRIMARY RESEARCH CONTRIBUTION OF KNOWLEDGE

The programme described above has contributed research to the knowledge of PSS and manufacturing methodology, especially in the area of assessing the competitiveness of a new PSS strategy, from a manufacturing point of view. This section highlights the primary contribution of this research.

10.2.1 The New PSSE Methodology

The main outcome of this research is the development of a new PSSE methodology. As shown in Figure 39, the new methodology consists of

seven well defined stages that are designed to assess the competitiveness of a new PSS strategy from a manufacturing point of view:

Stage 1: Scope issues
Stage 2: Identify Servitization Landscape
Stage 3: Design PSS
Stage 4: Review Competitive Strategy
Stage 5: Assess PSS Competitive Elements
Stage 6: Assess Servitizability of Company
Stage 7: Determine Type of PSS Competitive Strategy

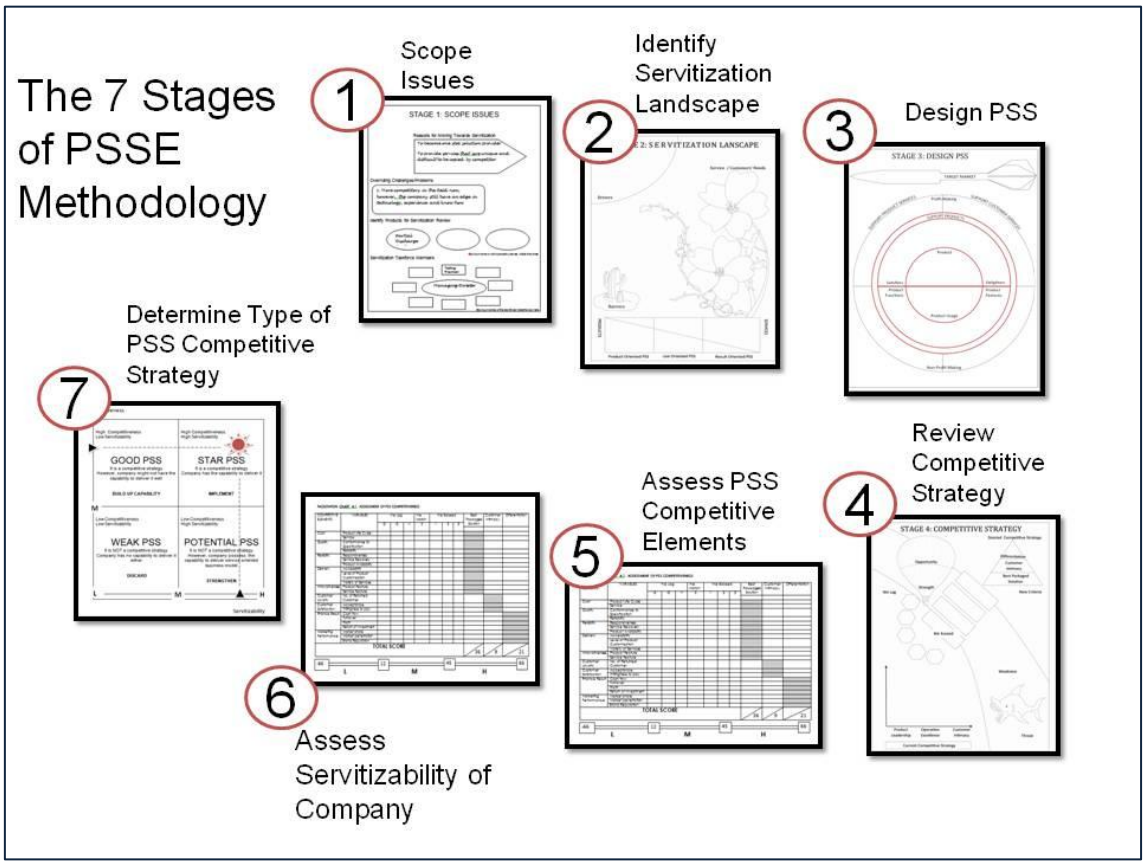


Figure 39: The Overall View of the Final PSSE Methodology

The usefulness, feasibility and usability of the PSSE methodology have been assessed and validated by both the researcher and via independent facilitators using industrial cases from Singapore's

manufacturing industry (Sections 8.3 and 9.4). Furthermore, the results of both the primary and secondary evaluations have demonstrated that the methodology is useful, feasible and usable and is able to deliver its expected outcomes (Sections 8.5 and 9.5). The new PSSE methodology has therefore been validated and is able to produce satisfactory results to assist companies in assessing whether the adoption of a new PSS strategy is a good competitive strategy. It has fulfilled the aim of this research and as a result has made the principal research contribution of this thesis.

10.3. SECONDARY RESEARCH CONTRIBUTIONS OF KNOWLEDGE

The secondary research contributions of knowledge are in the areas of the development of a new 'Framework for PSS Competitive Strategy', matrix for 'PSS Competitiveness Measurement', and a set of facilitation charts.

10.3.1 Framework of a PSS Competitive Strategy

The first secondary contribution of knowledge is the development of the framework of PSS competitive strategy. The framework provides an effective linkage of key manufacturing performance criteria to the competitive dimensions of a PSS strategy (Section 7.3.1).

Three strategic dimensions, namely, 'Best Packaged Solution', 'Customer Intimacy' and 'Differentiation' have been identified as the competitive dimensions of a new PSS competitive strategy:

- **Best Packaged Solution** –The primary focus of a PSS competitive strategy focuses in delivering complete total solutions to the customers via the best packaged products and services

- **Customer Intimacy** –The secondary focus of a PSS competitive strategy, its emphasis is on delivering best value in use, which is established on long term customer relationship, to ensure the best customer experience is provided and to develop Customer Intimacy
- **Differentiation** –A PSS competitive strategy creates a distinct Differentiation and value preposition through the offering of Best Packaged Solution and Customer Intimacy

The framework of the PSS competitive strategy has been used in the development of the PSSE methodology.

10.3.2 Matrix for PSS Competitiveness Measurement – PSS-CAM

The second secondary contribution of research knowledge is the 'PSS Competitiveness Measurement Matrix' (PSS-CAM). PSS-CAM has been developed to provide the final indication of the competitive position of a new PSS strategy. As shown in Figure 39, the combined scores of the competitiveness of PSS elements and Servitizability of a company in both the X and Y axes will place the new PSS strategy into one of the our competitive quadrants of the matrix. The end result will then indicate whether the new PSS strategy is a 'Star PSS', a 'Good PSS', a 'Potential PSS' or a 'Weak PSS' competitive strategy.

10.3.2 PSSE Facilitation Charts

The PSSE facilitation charts have been developed for use in a PSSE workshop. The purpose of the facilitation charts is to assist the facilitator in conducting the information generation and decision making sessions and to ensure effective discussion with the participating companies

during the PSSE facilitated workshop. The set of six new facilitation charts developed can be found in Appendix B, and they are:

- *Facilitation Chart 1: Scope Issues*
- *Facilitation Chart 2: Servitization Landscape*
- *Facilitation Chart 3: Design PSS*
- *Facilitation Chart 4: Review Competitive Strategy*
- *Facilitation Chart 5: PSS Competitive Elements Measurement Chart (PSS-CMC)*
- *Facilitation Chart 6: PSS Servitizability Measurement Chart (PSS-SMC)*
- *Facilitation Chart 7: PSS Strategy Competitiveness Assessment Matrix (PSS-CAM)*

This section has discussed the primary and secondary research contributions of this thesis. In the next section, the limitation of this research is described.

10.4. LIMITATIONS OF THE RESEARCH

This section gives an overview of the limitations of the research. Due to the nature of the research and constraints of the time allocated, there are limitations in term of depths and details in the development of the PSSE methodology and the evaluation of the methodologies using industrial applications, within the stipulated time frame.

10.4.1 Difficulty in Controlling the Evaluation Time and Condition

The main limitation of this research is that it was rather difficult to achieve full control of the desired testing condition. The researcher has very little control over the size of the participating team, the duration of the entire evaluation process, the content of the PSS strategy discussed, as well as

the time and venue allocated for the evaluation. Some cases were completed with only the top management members (i.e. CAD CAM Controller) and others with a more complete management and technical team (i.e. Hydro and Thermal Co. and Semi-con Equipment Co.). In the case of water heater Co., due to the financial crisis triggered by the world wide economic downturn, the entire management team was dissolved and the formal testing process was stopped prematurely at stage 3 which resulted in the researcher in completing the entire workshop separately with the operations team.

10.4.2 Simplicity of the PSS Cases Generated

In order to complete the evaluation of the PSSE methodology within the allocated time frame given by the companies and not to involve too many people in the PSS workshop, majority of the new PSS cases generated by the company in this research were generally not complex enough. All the cases tested or developed involved only one single product and a list of simple service ideas. The reason was that apart from having a small project team, most of the companies did not spend enough time to prepare for the workshop. This was partly due to the companies' mentality of testing a new methodology. Thus the end result is that the PSS designed at the end of the workshop tended to be a simple conceptual design and lacking of contents.

10.4.3 Difficulty in Validating Accuracy of the Input Information

The current PSSE methodology has adopted a step by step procedural structure in guiding the participants through a series of stages. The input and output of each stage was relied heavily upon the data generated by the participants manually. Therefore there is a tendency that the outcome of the stage or the overall evaluation result will lose its accuracy due to an anomalous result or irregularities in information

generated within the stage or from the previous stage. This situation is especially true under circumstances when the size of the participating team is too small or the team members generated the performance score of each of the competitive elements based on their "ideal score" rather than data drawn from the actual fact and market performance.

10.5. IMPROVEMENT AND DIRECTIONS OF FURTHER RESEARCH

This section examines areas that need future research and provide direction of future research in the competitiveness evolution of PSS strategy.

10.5.1 Assessment of the Competitiveness of a Sustainable PSS

Firstly, the PSSE methodology developed in this research has focused on evaluating the economic dimension of a PSS. However, as pointed out by some researchers in the PSS community, single-mindedly focusing on evaluating the economic sustainability will only result in success in the short run (Mont, 2004). In the long run, a PSS competitive strategy requires all three sustainable dimensions to be satisfied simultaneously. Thus, in the future, apart from the economic aspect, the PSSE methodology can be expanded to cover the evaluation of its competitive dimensions in both the environmental and social aspect of a new PSS strategy.

10.5.2 Evaluation of the Servitizability of Closed-loop PSS

Secondly, as mentioned in Section 10.3.4, the current PSSE methodology focuses on evaluating open-loop PSS, and does not take into consideration the evaluation of the Servitizability aspect of a company providing a closed-loop PSS. As a result, future PSSE methodologies can be expanded to cover the assessment of the capability of a company in policy areas relating to product take back such as reverse supply chain management and remanufacturing process.

10.5.3 Further Improvement on the Design of the Facilitation Charts

Thirdly, further research can be conducted to examine the effectiveness of the role of the facilitation charts in the PSSE facilitated workshop, as well as to improve the quality and design of the current set of facilitation charts, to make them more effective and professional in use. For example, the facilitation charts can be designed in such a way that they form a complete picture at the end, and are able to give the participants of the PSSE workshop a clear overview of what they have discussed.

10.5.4 Development of Graphical Tools for PSS Design Activities

Fourthly, due to the time constraints of the execution of this research, the new PSSE methodology did not include any graphical tools for detailed service scenario design. Graphical tools could be useful in visualising and effectively depicting the flow of the service operations. The current worksheets for designing PSS service activities within the PSSE methodology are in the form of block diagrams and tables, and as a result it did not provide an effective graphical depiction of the flow of the service operations. Therefore, a set of suitable graphical PSS design tools either based on suitable existing graphical service design tools or from a new concept, should be considered for development for the PSSE methodology in the future.

10.6. FINAL REMARKS OF THE CONCLUSIONS

This chapter has presented the primary and secondary research contributions of knowledge. It has also identified the limitation of the research and proposed recommendations for the direction of future research. This research has made significant contributions to the knowledge of PSS in the areas of methodology development, for the evaluation of competitiveness of a new PSS strategy, from a

manufacturing point of view. Therefore, hopefully the knowledge generated in this research will be beneficial to manufacturers who have intentions to move towards Servitization, by providing them with a feasible, usable, and useful methodology that is able to assess whether the adoption of a new PSS strategy is a good competitive strategy.

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APPENDICES

APPENDIX A: QUESTIONNAIRE FOR THE SURVEY

QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

Note: This form is designed as a guide for conducting the semi-structured interview prior to the development of the PSSE methodology. It also serves as a mean to record the content of the interviews.

1

1. What are the existing services provided by your company, and why are you providing these services?

List of Services:

List of Products:

Why?

QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

2

2. Do you have any intentions to include more new services in your current business? If yes, why and what services do you intend to provide?

List of New Services:

Productspecially designed to deliver the service (if any):

Why?

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QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

3

3. Do you use any methodologies or tools to assist you in the planning of new services?

YES	NO

4. Do you think Product-Service Mix offering is a competitive business strategy?

YES	NO

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QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

4

5. Are you aware of the concept of Product Service System (PSS) and Servitization?

YES	NO

6. Do you take into consideration of reducing environmental impact when designing new service/PSS strategy?

YES	NO

QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

5

Is going green vital for the company future survival?

YES	NO

7. Do you think there is a need to develop a new methodology to help company in assessing the competitiveness of the new service oriented strategy, assuming currently there isn't any such methodology available?

YES	NO

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QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

6

8. What are the contents of the methodology would you prefer?
(i.e. identify current business problems, identify future opportunities, identify critical success factor, SWOT analysis, service design process, analysing critical manufacturing areas to support new services etc.)

9. Do you prefer the methodology to be delivered via facilitated workshop or online software tools, and why?

Web based software tool ☐

Facilitated workshop ☐

Others ☐

Facilitated Workshop	Web based Software Tool

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QUESTIONNAIR for SEMI-STRUCTURED INTERVIEW

7

10. What are the factors that would affect your decision making process when come to the adoption of a new service or PSS strategy?

- Cost of investment ☐
- Cost of maintenance ☐
- Customer Acceptance ☐
- Service Design Process ☐
- Product Take back ☐
- Others ☐

11. Would you like to participate in the testing of the new PSS methodology?

YES	NO

APPENDIX B: THE DRAFT PSSE FACILITATOR'S GUIDE


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methodology
The PSSE Facilitator's Guide 2010
[Draft Version]
Written By Jenny Ang
June 2010

The PSSE Facilitator's Guide 2010

This facilitator's guide is intended to assist you in facilitating the Product Service System Evaluation (PSSE) workshop with companies who are interested in implementing Product Service System (PSS) as a competitive strategy.

For more information on the PSSE methodology and support materials required to conduct the PSSE workshop , please contact:

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Singapore (760643)

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Part 1

Facilitator's Information

Objective of the PSSE Workshop

The PSSE methodology was designed to support the understanding of the concept of PSS and to assist companies in assessing whether the adoption of a new PSS is a competitive strategy.

The objective of the PSSE workshop is to provide an opportunity to explore in greater detail with the companies in issues related to the implementation of the new PSS strategy using the PSSE methodology, which consists of the following stages:

Stage 1: Scope issues
Stage 2: Identify Servitization Landscape
Stage 3: Design PSS
Stage 4: Review Competitive Strategy
Stage 5: Assess PSS Competitive Elements
Stage 6: Assess Servitizability of Company
Stage 7: Determine Type of PSS Competitive Strategy

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Part 1

Facilitator's Information

Requirements of the Facilitator

In order to effectively facilitate the PSSE workshop:

You must have a thorough understanding of the structure of the PSSE methodology. The detailed description of the structure of the PSSE methodology is contained in Part 2 of this facilitator's guide.

You may wish to read out more information about PSS, Servitization and Competitive Strategy. A list of references is appended at the back of this facilitator's guide for your reference.

You need not to be a certified highly skilled facilitator however you must be equipped with basic skill in facilitating a group discussion, and prepared to answer any answers related to PSS, Servitization and Competitive Strategy and based on the needs of the workshop and of the participants, provide consultancy in issues related to the implementation of the new PSSE methodology

You must have a very clear understanding of the end deliverables wish to be to accomplished by the end of the PSSE workshop and provide means to guide the participants to deliver the final results.

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Part 1

Facilitator's Information

Structure of the PSSE Workshop

The workshop can be conducted within the same day or over a two-day period (or several half-day sessions) if the companies need to work on a detailed PSS strategy. However, it is advised that all the exercises in a stage must be completed at the end of every session before the start of the new session. New session can be started within the same day or on a different day.

Suggested programme of a one-day workshop:

9:00 - 9:15	Introduction and forming the project team
9:15 - 9:30	Presentation: What is PSSE methodology?
9:30 – 10:00	Stage 1: Scope Issues
10:00 -11:00	Stage 2: Identify Servitization Landscape
11:00 – 12:00	Stage 3: Design PSS
12:00 – 1:00	Lunch
1:00 – 2:30	Stage 4: Review Competitive Strategy
2:30 - 3:00	Stage 5: Assess the Competitive PSS Elements
3:00 - 3:15	Tea Break
3:15 – 3:45	Stage 6: Assess the Servitizability of the Company
3:45 - 4:15	Stage 7: Generate the Final PSS Competitiveness Score Card
4:15 – 5:00	Discussion of Future Actions
5:00 – 5:30	Post Workshop Evaluation

Suggested Format of a two-day workshop:

Day 1:
Stage 1: Scope issues
Stage 2: Identify Servitization Landscape
Stage 3: Design PSS

Day 2:
Stage 4: Review Competitive Strategy
Stage 5: Assess the Competitive PSS Elements
Stage 6: Assess the Servitizability of the Company
Stage 7: Generate the Final PSS Competitiveness Score Card
Post Workshop Evaluation

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Part 1

Facilitator's Information

Workshop Logistics

The following items are required to conduct the workshop:

Printed Materials:
✓A. Set of PSSE Facilitation Charts (A0 size, one set per workshop)
✓B. Set of PSSE Worksheets (A4 size, one set per participant)
✓C. Set of PSSE Presentation Slides (A4 size, one set per participant)
✓D. Set of Post PSSE Workshop Assessment Form (A4 size, one set per participant)

Items B-D can be printed in double sized paper and ring-bind with a workshop cover page. However, the post workshop assessment would need to be detached from the booklet after the workshop evaluation.

Stationery:
✓A few stacks of post-in note pads in various sizes and colors
✓White board markers
✓Masking tapes
✓Pens
✓Flip chart and stand

All participants will be issued with a set of worksheets.
Facilitation charts are to be used for brainstorming sessions.
Guidelines in using the worksheets and facilitation charts required for the workshop can be found in Part 3 of this guide.

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Part 2

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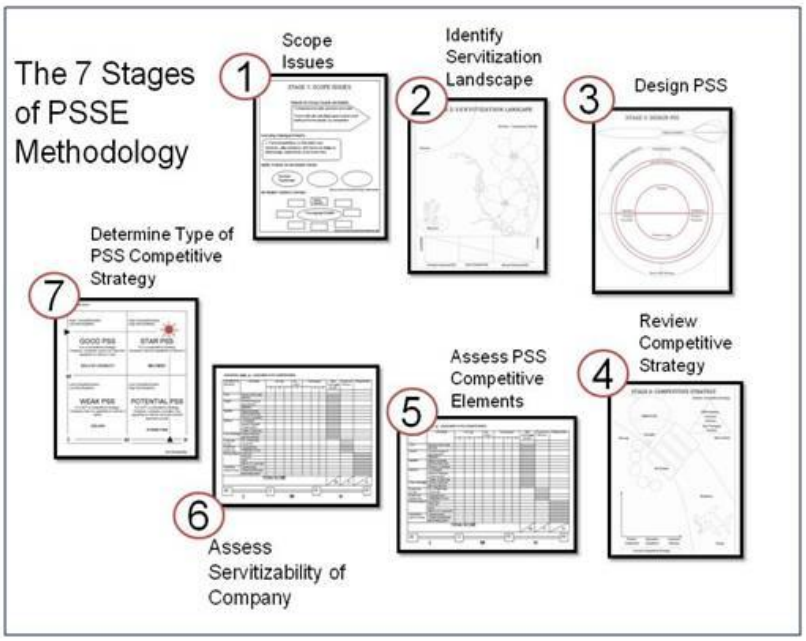
Structure of the PSSE Methodology



Stage 1: Scope issues
Stage 2: Identify Servitization Landscape
Stage 3: Design PSS
Stage 4: Review Competitive Strategy
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Stage 7: Determine Type of PSS Competitive Strategy

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Part 2

The PSSE Methodology

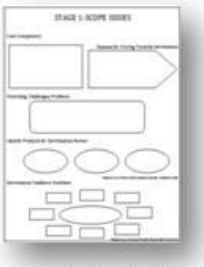
Stage 1: Scope Issues

Introduction:
The first stage of the PSSE methodology consists of steps that are designed to identify core competency of the company, reasons for Servitization, overriding problems and challenges. The intention of stage 1 is to guide the participants in understanding their current situation and the desire of moving towards adopting a new strategy. Stage 1 of the PSSE methodology also explores the potential range of products that can be used in the new PSS strategy. At the end of this stage, a Servitization task force team will be formed in order to continue working on identifying the Servitization landscape in Stage 2 and designing the new PSS activities in Stage 3.

Objectives:
1. To brainstorm on the overriding challenges and problems faced by the current product oriented competitive strategy and the reasons of moving towards Servitization
2. To form the project team for designing the new PSS strategy

Facilitation Chart:
Facilitation Chart 1: Scope Issues

Worksheet:
Worksheet 1.1



Facilitation Chart 1: Scope Issues

Worksheet 1.1: Role of the PSS Project Team

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Stage 1: Scope Issues

Time Frame:
30-45 minutes

Steps:
Step 1: Identify core competency of the company
Step 2: Discuss reasons for Servitization
Step 3: Discuss overriding problems and challenges
Step 4: Identify products to be used for the new PSS competitive strategy
Step 5: Identify role for the project team

Facilitation Process:

1. Brainstorm on core competency, reason of going for Servitization, current overriding problems and challenges faced by the company by using facilitation chart 1
2. Encourages all the participants to actively write down their thoughts on the post-in notes and stick in on the respective boxes on the facilitation chart
3. Discuss on the possible product ranges and business areas for Servitization
4. Discuss on the roles on the team members and the importance of forming a cross-functional team for the formulation of the new PSS strategy
5. Encourage the participants to work on worksheet 1.1 separately on the filling up the designation and role of all the team members

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Part 2

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Stage 2: Identify Servitization Landscape

Introduction:
The second stage of the PSSE methodology focuses on discussing issues related to the customer needs. During this stage, the focus is on the product features that can be used to fulfil the needs of the customers, the drivers and barriers towards Servitization, and the list of current and new services for the new PSS strategy will be discussed. This stage of the PSSE methodology also helps the company in classifying the types of new PSS strategy into a 'Product Oriented PSS', 'Use Oriented PSS' or 'Service Oriented PSS'.

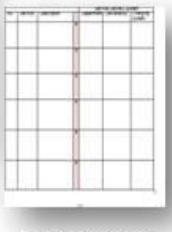
Objectives:
1. To understand the needs of the customers
3. To identify drivers and barriers towards Servitization
4. To produce a list of new PSS services
5. To identify the new PSS model

Facilitation Chart:
Facilitation Chart 2: Servitization Landscape

Worksheets:
Worksheet 2.1: Understanding Customer Needs
Worksheet 2.2: Identify PSS Services

Facilitation Chart 2: Servitization Landscape

Worksheet 2.1: Understanding Customer Needs



Worksheet 2.2: Identify PSS Services

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Part 2

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Stage 2: Identify Servitization Landscape

Time Frame:
30-60 minutes

Steps:
Step 1: Understand Customer Needs
Step 2: Identify Drivers and Barriers towards Servitization
Step 3: Brainstorm on new services for PSS
Step 4: Identify the new PSS Model

Facilitation Process:

1. Discuss with the participants the needs of the customers, the satisfiers and the delighters, and identify the product features that will support the customer needs by using worksheet 2.1. Input the results onto Facilitation chart 2
2. Brainstorm on driver and barriers of moving towards Servitization
3. Discuss with the participants all the potential services, in the categories of Services Supporting Product (SSP) and Services Supporting Customers (SSC). Participants are encouraged to work on what they have discussed on the worksheet 2.2 individually
4. Input the list of discussed services onto the PSS model at the bottom of the facilitation chart and discuss with the participants the three different PSS models, namely, Product Oriented PSS, Use Oriented PSS and Result Oriented PSS

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Part 2

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Stage 2: Identify Servitization Landscape

Types of PSS Model

Product Orientated PSS - Product Oriented PSS focuses in selling the product which includes additional add on services as part of the end offering to support the operational qualify of the product. Ownership of the Product Oriented PSS can be retained by the manufacturer but is normally transferred to the users. This type of PSS is commonly adopted by manufacturers who have a widely installed base or to ensure the products sold are operating in good condition. Examples of Product Oriented PSS are maintenance, repair, reuse, recycling, training, consultancy, installation, upgrading and disposable service etc.

Use Orientated PSS - Use Oriented PSS focuses in selling the availability or use of a product through activities like leasing or sharing. Usually, the ownership of the product in a Use Oriented PSS does not belong to the customer. The utilization of the product is operated through the purported sharing activities and ownership of the product is normally still retained by the manufacturer. Examples of Use Oriented PSS are, pooling, leasing, renting and inventory buffering support etc.

Result Orientated PSS - Result Oriented PSS focuses in selling the functionality or end results instead of a product. Its business model is based on selling a result preposition that is guaranteed by the manufacturers with the provision of Informative product that is specially designed to deliver the promised result and to facilitate maintenance and optimisation of the use phase efficiency. Typical examples of Result Oriented PSS are "Selling the copying" by Canon and Xerox, "Selling the power-of-the-hour" by Rolls Royce's engine service, "Selling the driving" by car sharing service provider and "Selling the washing" by community laundrette centre.

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Part 2

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Stage 3: Design PSS

Introduction:
The third stage of the PSSE methodology consists of steps mainly to work on the operation and service delivery system of the new PSS strategy. It involves reviewing the current activities of the company as well as working on the new activities that are required to deliver the new PSS strategy. During this stage, the critical resources that are required to support the new PSS activities can also be discussed.

Objectives:
1. To design activities that will support the services identified in Stage 2
2. To identify critical resources to support the PSS activities
3. To identify services that support both the products and customers

Facilitation Chart:
Facilitation Chart 3: Design PSS

Worksheets:
Worksheet 3.1: Design Activities for PSS
Worksheet 3.2: Identify Critical Resources for new PSS

Facilitation Chart 3: Design PSS

Worksheet 3.1: Design Activities for PSS

Worksheet 3.2: Identify Critical Resources for new PSS

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Part 2

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Stage 3: Design PSS

Time Frame:
60 – 120 minutes

Steps:
Step 1: Identify activities related to the delivery of the new PSS
Step 2: Identify features of the products to support the new PSS
Step 3: Identify Critical Resources for the new PSS Activities
Step 4: Identify services that support both the products and customers
Step 5: Identify targeted market

Facilitation Process:
1. Brainstorming on the activities and critical resources that are required to support the new PSS strategy by using facilitation chart 3 – Design PSS
2. Using worksheet 3.1 to record all the new activities related to the delivery of the new PSS strategy in the areas of *Origin of Product, Manufacturing Facilities, Manufacturing Activities, Quality Control, Finished Product, Marketing, Sales, Admin, Service and Delivery of Services*
3. Using worksheet 3.2 to identify critical resources in the aspects of *Physical, Financial, Human, Technological, Organisational and Reputation* related to the identified new PSS activities

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Part 2

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Stage 4: Review Competitive Strategy

Introduction:
The forth stage of the PSSE methodology consists of steps to review the current competitive strategy of the company. It helps to identify whether the current competitive strategy is based on 'Product Leadership', 'Customer Intimacy or 'Operation Excellence'. During this stage, a 'SWOT' analysis will be conducted to gain a better understanding of the company's industrial competitive position and the critical success factor that is crucial in delivering the new PSS strategy can be discussed.

Objectives:
1. To brainstorm on the *Strength, Weakness, Opportunity and Threat* of the company
2. To review the current competitive strategy of the company
3. To identify critical success factor in delivering the new PSS strategy
4. To identify the desired competitive strategic position of the new PSS strategy

Facilitation Chart:
Facilitation Chart 4: Review Competitive Strategy

Facilitation Chart 4: Review Competitive Strategy

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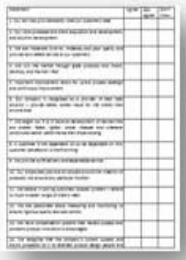
The PSSE Methodology

Stage 4: Review Competitive Strategy

Worksheets:
Worksheet 4.1: SWOT Analysis
Worksheet 4.2: Review Current Competitive Strategy
Worksheet 4.3: Score Card for Competitive Strategy

Worksheet 4.1: SWOT Analysis



Worksheet 4.2: Review Current Competitive Strategy

Worksheet 4.3: Score Card for Competitive Strategy

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Part 2

The PSSE Methodology

Stage 4: Review Competitive Strategy

Time Frame:
60 – 120 minutes

Steps:
Step 1: Perform SWOT Analysis
Step 2: Review Current Competitive Strategy
Step 3: Identify critical success factor in delivering the new PSS strategy
Step 4: Discuss on the desired competitive strategic position of the new PSS strategy

Facilitation Process:

1. Brainstorm on the *Strength, Weakness, Opportunity and Threat* of the company by using facilitation chart 4.
2. Discuss on the areas that the company excelling and lagging behind its competitors
3. Using worksheet 4.1 to record the *Strength, Weakness, Opportunity and Threat* of the company
4. Answer questions in worksheet 4.2 in order to review their current competitive strategy
5. Tabulate the results by using worksheet 4.3. Please note that score must be the average score of all the participants.
6. Plot the graph of the score of *Product Leadership, Customer Intimacy or Operation Excellence in facilitation chart 4*
7. Discuss with the participants on their current competitive strategy position whether it is based on *Product Leadership, Customer Intimacy or Operation Excellence based on the scores generated*
8. Discuss with the team on the new desired PSS competitive positions, namely *Best Packaged Solution, Customer Intimacy and Differentiation*

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Part 2

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Stage 5: Assess PSS Competitive Elements

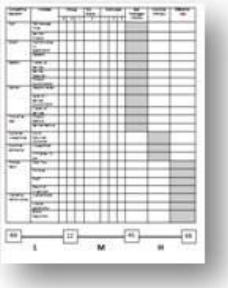
Introduction:
The fifth stage of the PSSE methodology consists of steps to assess the competitiveness of the PSS elements. It assesses the competiveness of the three PSS competitive dimensions, *'Best Packaged Solution', 'Customer Intimacy' and 'Differentiation'* of the proposed PSS strategy. This stage makes use of the 'PSS Competitive Element Measurement Chart '(PSS-CMC) to produce the results of 'PSS Competitiveness' by asking the participants to go through a list of 22 questions in the three competitive dimensions. The participants will be asked to give a score of -3 to 3 to each of the questions and competitiveness of the PSS elements will be rated as low, if the final score is below 34 and high if the final score is above 34.

Objectives:
1. To discuss on the three competitive dimension of PSS, namely, Best Packaged Solutions, Customer Intimacy and Differentiation
2. To generate the over score of the competitiveness of the PSS competitive dimensions

Facilitation Chart:
Facilitation Chart 5: *PSS Competitive Elements Measurement Chart (PSS-CMC)*

Worksheets:
Worksheet 5.1:
PSS Competitive Elements Measurement Chart (PSS-CMC)

Worksheet 5.1: *PSS Competitive Elements Measurement Chart (PSS-CMC)*



Facilitation Chart 5: *PSS Competitive Elements Measurement Chart (PSS-CMC)*

[Note: the format of both worksheet 5.1 and facilitation chart 5 are the same]

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Part 2

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Stage 5: Assess PSS Competitive Elements

Time Frame:
30-60 minutes

Steps:
Step 1: Discuss the PSS competitive dimensions and its variables
Step 2: Generate overall score of the competitive dimensions

Facilitation Process:

1. Discuss with the participants the three competitive dimensions of PSS, namely, *Best Packaged Solutions, Customer Intimacy and Differentiation*, and the variables that made up these three dimensions. You can discuss with the participant to modify the variables if necessary, assign weighting factor to the variables
2. Using worksheet 5.1, and give sufficient time (around 15-30 mins) to allow the participants to work on it individually
3. Discuss the results by input all the scores from the participants onto the facilitation chart 5 and produce a set of final average score for the three PSS competitive dimensions
4. Discuss with the participants if the results between the participants vary too much. Try to understand the reason behind the scores.
5. You might want to produce a set of scores from the management members and another set from the staff if the participating team is big enough
6. Mark the final score onto the competitiveness bar line below the facilitation chart. It gives a pointer of PSS competitiveness from Low (L) to Medium (M) to High (H)

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Stage 5: Assess PSS Competitive Elements

Three strategic elements, namely, Best Packaged Solution, Customer Intimacy and Differentiation form the competitive dimensions of a new PSS competitive strategy:

- **Best Packaged Solution** – The first competitive dimension of a PSS competitive strategy is the *Best Packaged Solution*. The primary focus of a PSS competitive strategy focuses in delivering a complete total solutions to the customers via best packaged of product and services

- **Customer Intimacy** – The second competitive dimension is *Customer Intimacy*. The secondary focus of a PSS competitive strategy emphasizes on delivering best value in use, which is establishing on long term customer relationship, thus it is able to provide best customer experience and develop customer intimacy

- **Differentiation** – The third competitive dimension is *Differentiation*. A PSS competitive strategy creates a distinct differentiation and value preposition through the offering of best packaged solution and customer intimacy

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Stage 6: Assess Servitizability of Company

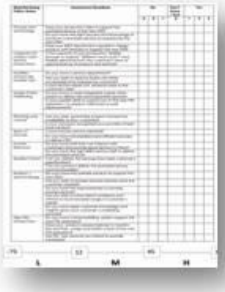
Introduction:
The sixth stage of the PSSE methodology assesses the level of Servitizability of the company in term of its structure and infra-structure policy areas. The purpose is to determine whether the company possesses the right capability to deliver the new PSS strategy both structurally and infra-structurally. This stage makes use of the 'PSS Servitizability Measurement Chart' (PSS-SMC) to generate the results of the Servitizability of the company by asking the participants to go through a list of 25 questions in order, in the areas of structure and infra-structure policy areas. The participants will then be asked to give a score of -3 to 3 to each of the questions; This will allow Servitizability of the company to be rated as low, if the final score is below 37 and high if the final score is above 37.

Objectives:
1. To discuss on the Servitizability of the company
2. To generate the over score of the Servitizability of the Company

Facilitation Chart:
Facilitation Chart 6: PSS Servitizability Measurement Chart (PSS-SMC)

Worksheets:
Worksheet 6.1: PSS Servitizability Measurement Chart

Worksheet 6.1: *PSS Servitizability Measurement Chart*



Facilitation Chart 6: *PSS Servitizability Measurement Chart (PSS-SMC)*

Part 2

The PSSE Methodology

Stage 6: Assess Servitizability of Company

Time Frame:
30-60 minutes

Steps:
Step 1: Discuss the Servitizability of the company
Step 2: Generate overall score of the Servitizability of the company

Facilitation Process:

1. Discuss with the participants the manufacturing areas that are crucial in delivering the new PSS strategy
2. Allow the participants to work on worksheet 6.1 individually
3. Discuss the results by input all the scores from the participants onto the facilitation chart 6 and work on the final average score
4. Discuss with the participants if the results between each of the participants vary too much. Try to understand the reason behind the scores and work on the final score
5. Mark the final score onto the Servitizability bar line below the facilitation chart. It gave a pointer of Servitizability of the company from Low (L) to Medium (M) to High (H)

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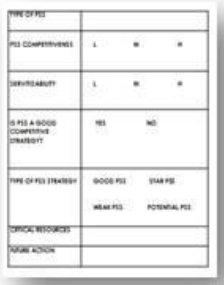
Stage 7: Determine Type of PSS Competitive Strategy

Introduction:
The last stage of the PSSE methodology consolidates the outcomes and assesses the competitiveness of the new PSS strategy by using the 'PSS Competitiveness Assessment Matrix' (PSS-CAM). The final result is produced by placing the score of the 'PSS Competitive Dimensions' and the 'Servitizability' on the matrix. The assessment matrix will allow the determination of the new PSS strategy as a 'STAR PSS', 'GOOD PSS', 'POTENTIAL PSS' or a 'WEAK PSS'. The final score in this stage will then provide summarised information about the type of PSS strategy, Level of PSS element competitiveness, level of Servitizability, critical resources required to deliver the new PSS activities and future actions.

Objectives:
1. To generate the score of the final PSS assessment
2. To discuss on the results and future plan

Facilitation Chart:
Facilitation Chart 7: PSS Competitiveness Assessment Matrix

Worksheets:
Worksheet 7.1: PSSE Report Card and Future Actions



Worksheet 7.1: *PSSE Report Card and Future Actions*

Facilitation Chart 7: *PSS Competitiveness Assessment Matrix*

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The PSSE Methodology

Stage 7: Determine Type of PSS Competitive Strategy

Time Frame:
30-60 minutes

Steps:
Step 1: Discuss the results produced in stage 5 and 6 of the PSSE workshop
Step 2: Determine the type of the new PSS competitive strategy
Step 3: Discuss future actions

Facilitation Process:

1. Discuss with the participants on the results produced by stage 5 and stage 6
2. Using facilitation chart 7, mark the score generated by stage 5 along the x axis and the score generated by stage 6 along the y axis of the Facilitation Chart 7
3. Discuss the results with the participants and explain to them the characteristics of the 4 different types of PSS competitive strategies, namely, *STAR PSS, GOOD PSS, POTENTIAL PSS and WEAK PSS*
4. Using worksheet 7.1, discuss with the participants the future plan by summarising the keys points generated in the entire PSSE workshop

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The PSSE Methodology

Stage 7: Determine Type of PSS Competitive Strategy

The combined scores of PSS Competitiveness (Stage 5) and Servitizability (Stage 6) will place the new PSS strategy into the following four categories:

STAR PSS Strategy -- *High PSS Competitiveness and High Servitizability*
With a high PSS Competitiveness and high Servitizability, the new PSS strategy will be assessed as a 'STAR Competitive Strategy' for a company. The recommendation to the company is to implement it.

GOOD PSS Strategy -- *High PSS Competitiveness and Low Servitizability*
With a high PSS Competitiveness and low Servitizability, the new PSS strategy will be assessed as a 'GOOD Competitive Strategy' for a company. Although the new PSS strategy has good PSS features, the company does not possess the right capability or policies to deliver it. The recommendation to the company is to improve their service delivery system and capability first before implementing the new PSS strategy.

POTENTIAL PSS Strategy - *Low PSS Competitiveness and High Servitizability*
With a low PSS Competitiveness but high Servitizability, the new PSS strategy will be assessed as a 'POTENTIAL Competitive Strategy' for a company. Although the company has the capability to deliver the new PSS strategy, the weakness of the PSS features and elements, cause it to be classified as a poor competitive strategy. The recommendation to the company is to improve on the features of the new PSS strategy before implementing it.

WEAK PSS Strategy - *Low PSS Competitiveness and Low Servitizability*
With both low PSS Competitiveness and Servitizability, the new PSS strategy will be assessed as a 'WEAK Competitive Strategy' for a company. The recommendation to the company is to discard the new PSS strategy or to re-design new PSS features and activities, and to continue to build up the company's PSS delivery capability.

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Part 3

PSSE Presentation Slide

This set of presentation slides is to be used at the beginning of the PSSE workshop to provide the participants with sufficient background information of the concept of PSS and Servitization prior to the start of the PSSE workshop.

Duration of the presentation times is approximately 15-30 minutes.

Structure of the flow of the presentation is as follows:

Slide 1: A Methodology for Adopting PSS As a Competitive Strategy for Manufacturer
Slide 2: The PSSE Methodology
Slide 3,4: What is Product Service System (PSS)?
Slide 5: PSS Category
Slide 6: PSS Examples
Slide 7: What is Servitization?
Slide 8: What is Servitizability?
Slide 9,10: What is a PSS Competitive strategy?
Slide 11,12: The PSS Competitive Elements
Slide 13: PSS Competitive Elements Assessment Chart
Slide 14: PSS Servitizability Assessment Chart
Slide 15: PSS Strategy Competitiveness Assessment Matrix
Slide 16: The 7 Stages of PSSE Methodology
Slide 17: Stage 1: Scope issues
Slide 18: Stage 2: Identify Servitization Landscape
Slide 19: Stage 3: Design PSS
Slide 20: Stage 4: Review Competitive Strategy
Slide 21: Stage 5: Assess PSS Competitive Elements
Slide 22: Stage 6: Assess Servitizability of Company
Slide 23: Stage 7: Determine Type of PSS Competitive Strategy
Slide 24: Contact Information

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[Slide 1 -2]

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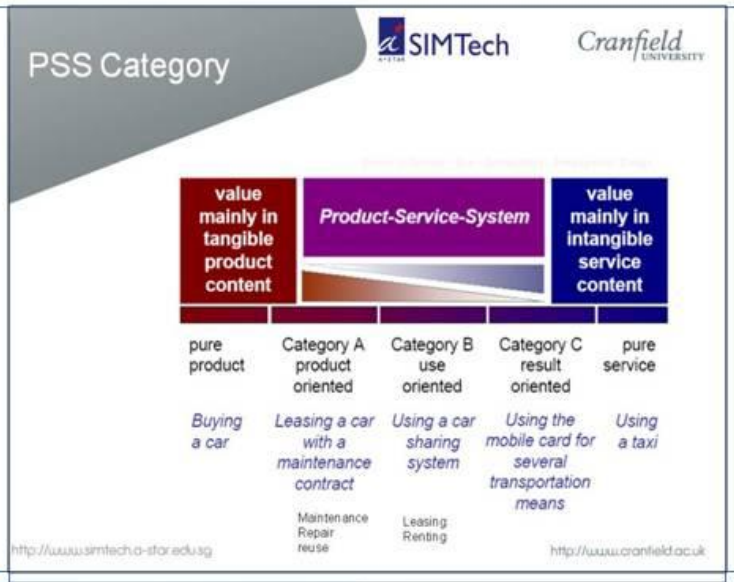

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Part 3

PSSE Presentation Slide

What is Servitization?

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Servitization is the innovation of an organisations capabilities and processes to better create mutual value through a shift from selling product to selling PSS

- Baines et al.

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What is Servitizability?

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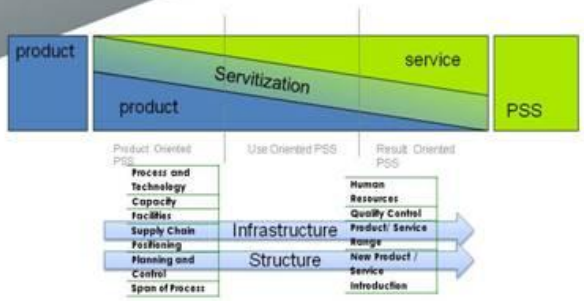

The ability of a manufacturer to effectively transform its operations to support the Servitization strategy, both structurally and infra-structurally

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[Slide 7-8]

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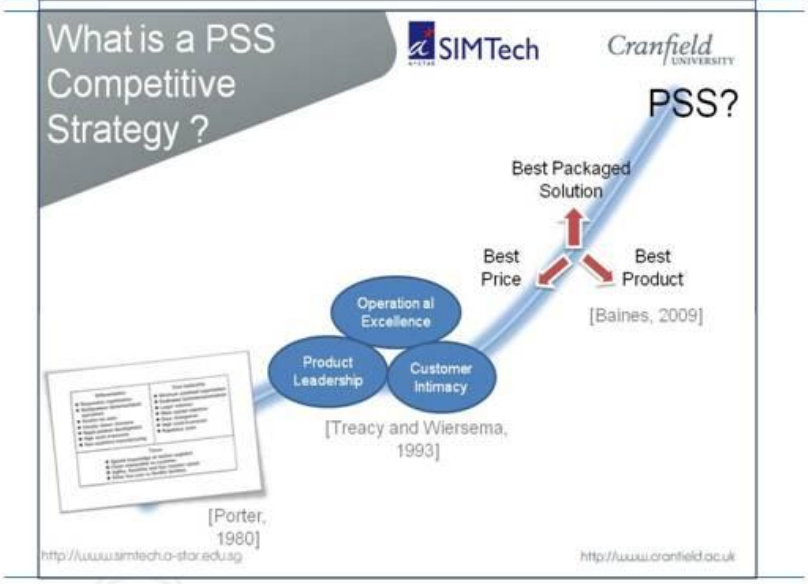

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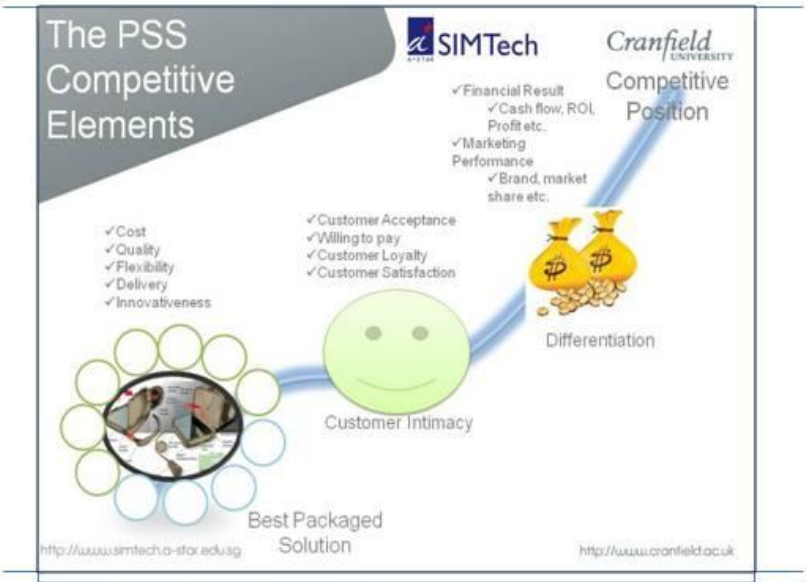

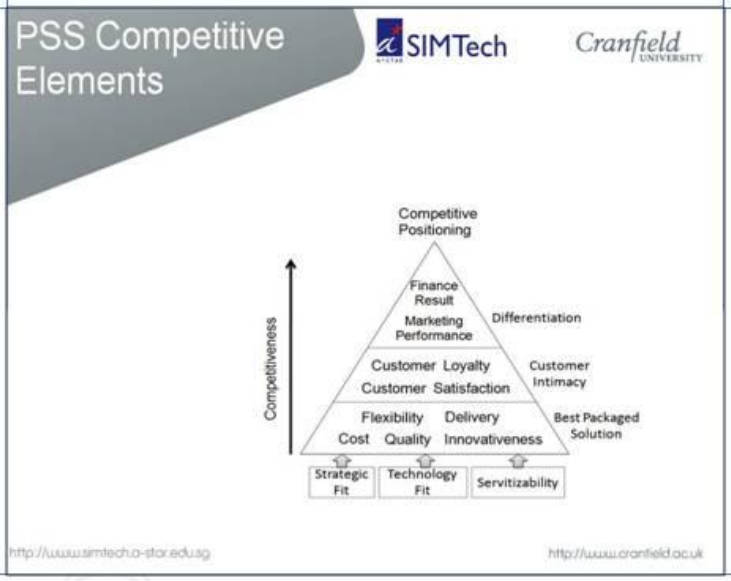

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Part 3

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PSS Competitive Elements Assessment Chart

COMPETITIVE ELEMENTS	VARIABLES	We Lag			We Match	We Exceed			Best Package dSolution	Customer Intimacy	Differentiation
		-4	-3	-2	-1	1	2	3			
Cost	Product Life Cycle										
	Service										
Quality	Conformance to Specification										
	Reliability										
Flexibility	Service Customisation										
	Service Recovery										
	Product Customisation										
Delivery	Responsiveness										
	Level of Product Customisation										
	Variety of Services										
Innovativeness	Product Feature										
	Service Feature										
Customer Loyalty	No. of Returned Customer										
Customer Satisfaction	Acceptance, Willingness to pay										
Finance Result	Cash flow										
	Turnover										
	Profit										
	Return of Investment										
L mance	Market penetration										
	Brand Reputation										

L M H

PSS Servitizability Assessment Chart

Manufacturing Policy Areas	VARIABLES	No			N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							x
	Do you have the right process and technology to produce customised service as required by the new PSS?							x
	Does your R&D department capable in design product with features to support the new PSS?					x		
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point" and flexible demands from the customer in term of special feature of product and service?		x					
Facilities - factory size, location etc.	Do you have a service department?							
	Are you able to replace faulty unit within acceptable time required by customer?	x						
	Is your factory repair unit physical close to the customer's site?				x			
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?				x			
	Is your supplier able to support you in the new PSS operation, i.e. product take back or part replacement?				x			
Planning and Control	Are you able guarantee product and service availability to your customer?						x	
	Is your company recognised as a provider of best total solution?							
Span of process	Is your process service-oriented?						x	
	Do you have standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide good service to them?						x	
	Do you have the right skills in service staff to deliver the promised service?							x
[illegible] production	Do you have a finance/billing system support the[illegible]operation?							
	[illegible] your [illegible] operation?							
	Are the new services you intend to provide inimitable?							

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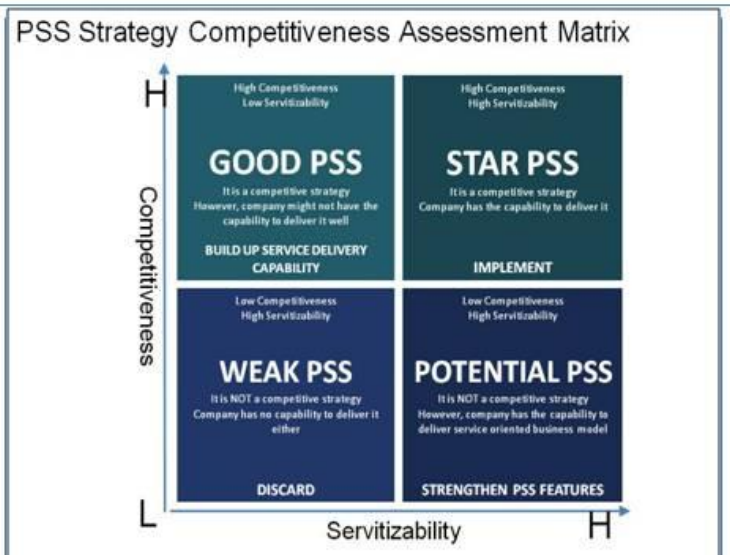

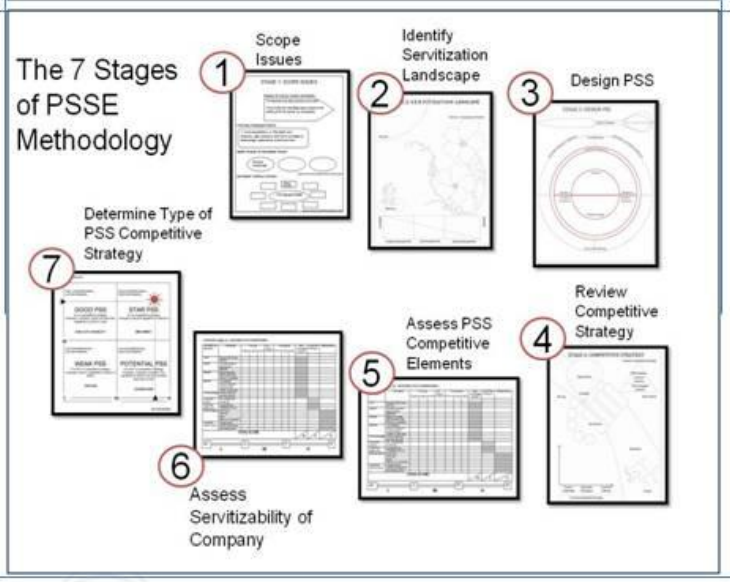

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Part 3

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Stage 1: Scope Issue

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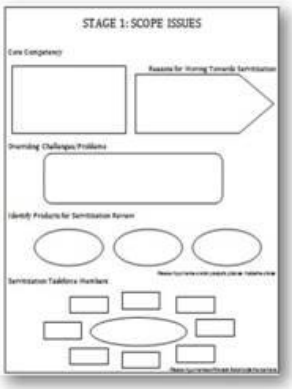

Time Frame:
30- 45 minutes

Steps:
✓Step 1: Identify core competency of the company
✓Step 2: Discuss reasons for Servitization
✓Step 3: Discuss overriding problems and challenges
✓Step 4: Identify products to be used for the new PSS competitive strategy
✓Step 5: Identify role for the project team

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Stage 2: Servitization Landscape

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Time Frame:
30- 60 minutes

Steps:
✓Step 1: Understand Customer Needs
✓Step 2: Identify Drivers and Barriers towards Servitization
✓Step 3: Brainstorm on new services for PSS
✓Step 4: Identify the new PSS Model

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Part 3

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Stage 3: Design PSS

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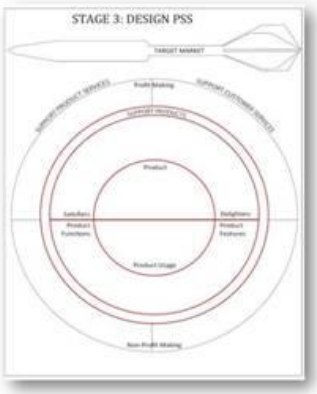
Time Frame:
60 – 120 minutes

Steps:
✓Step 1: Identify activities related to the delivery of the new PSS
✓Step 2: Identify features of the products to support the new PSS
✓Step 3: Identify Critical Resources for the new PSS Activities
✓Step 4: Identify services that support both the products and customers
✓Step 5: Identify targeted market



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Stage 4: Review Competitive Strategy

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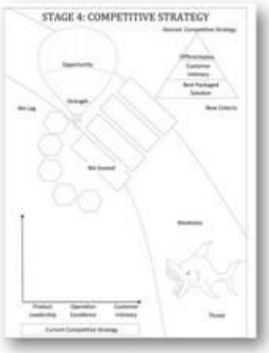
Time Frame:
60 – 120 minutes

Steps:
✓Step 1: Perform SWOT Analysis
✓Step 2: Review Current Competitive Strategy
✓Step 3: Identify critical success factor in delivering the new PSS strategy
✓Step 4: Discuss on the desired competitive strategic position of the new PSS strategy



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Part 3

PSSE Presentation Slide

Stage 5: Assess PSS Competitive Elements

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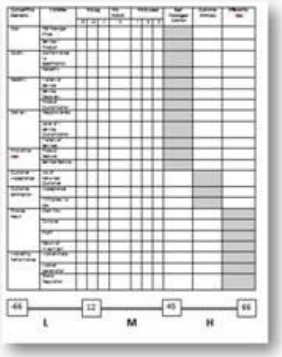

Time Frame:
30-60 minutes

Steps:
✓Step 1: Discuss the PSS competitive dimensions and its variables
✓Step 2: Generate overall score of the competitive dimensions

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Stage 6: Assess Servitizability of Company

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Time Frame:
30-60 minutes

Steps:
✓Step 1: Discuss the Servitizability of the company
✓Step 2: Generate overall score of the Servitizability of the company

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Stage 7: Determine Type of PSS Competitive Strategy

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Time Frame:
30-60 minutes

Steps:
✓Step 1: Discuss the Servitizability of the company
✓Step 2: Generate overall score of the Servitizability of the company

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The PSSe methodology

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Jenny ANG
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THANK YOU

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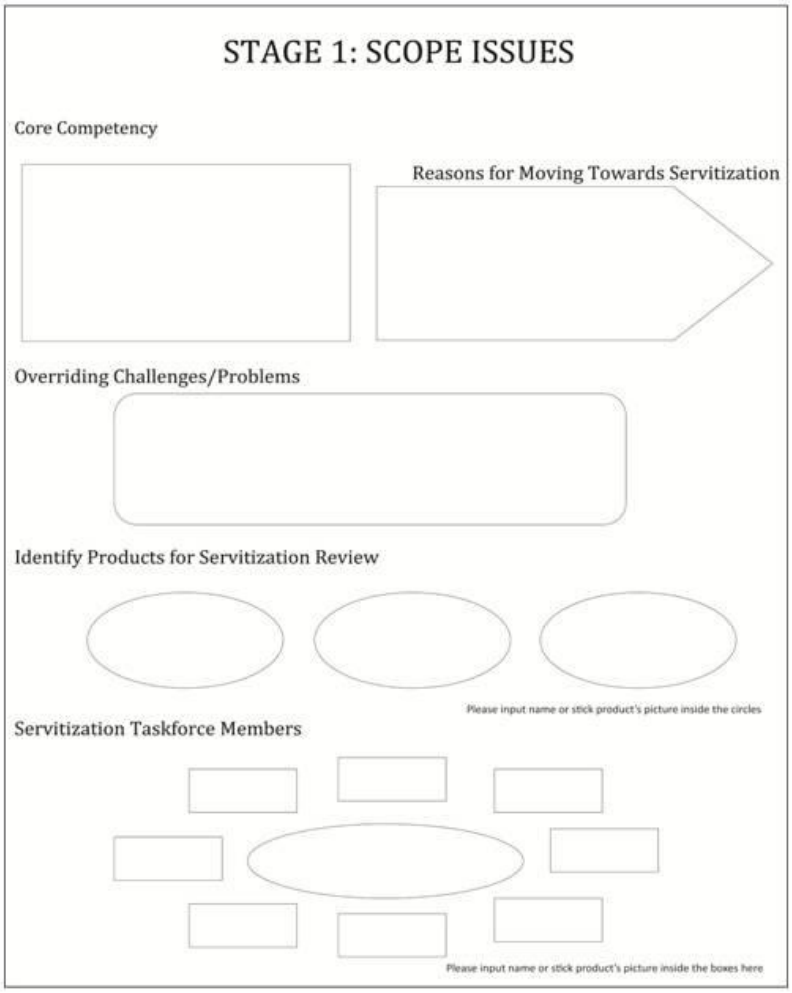
Part 4

PSSE Facilitation Chart

Facilitation Chart 1: Scope Issues



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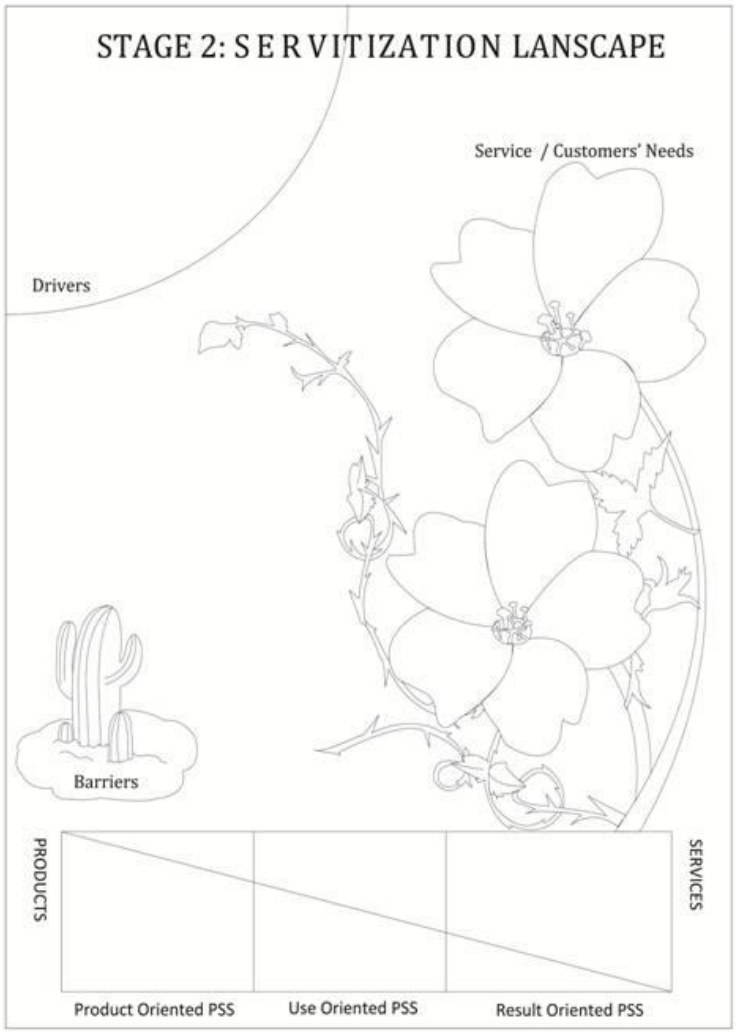
Part 4

PSSE Facilitation Chart

Facilitation Chart 2: Servitization Landscape



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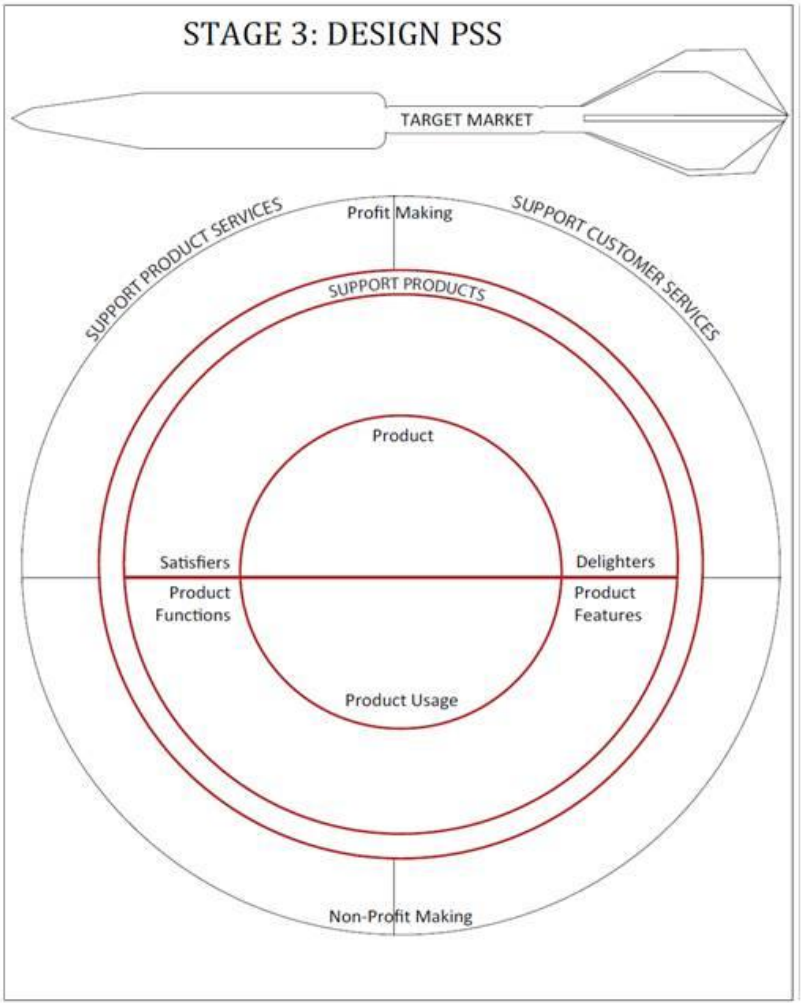
Part 4

PSSE Facilitation Chart

Facilitation Chart 3: Design PSS



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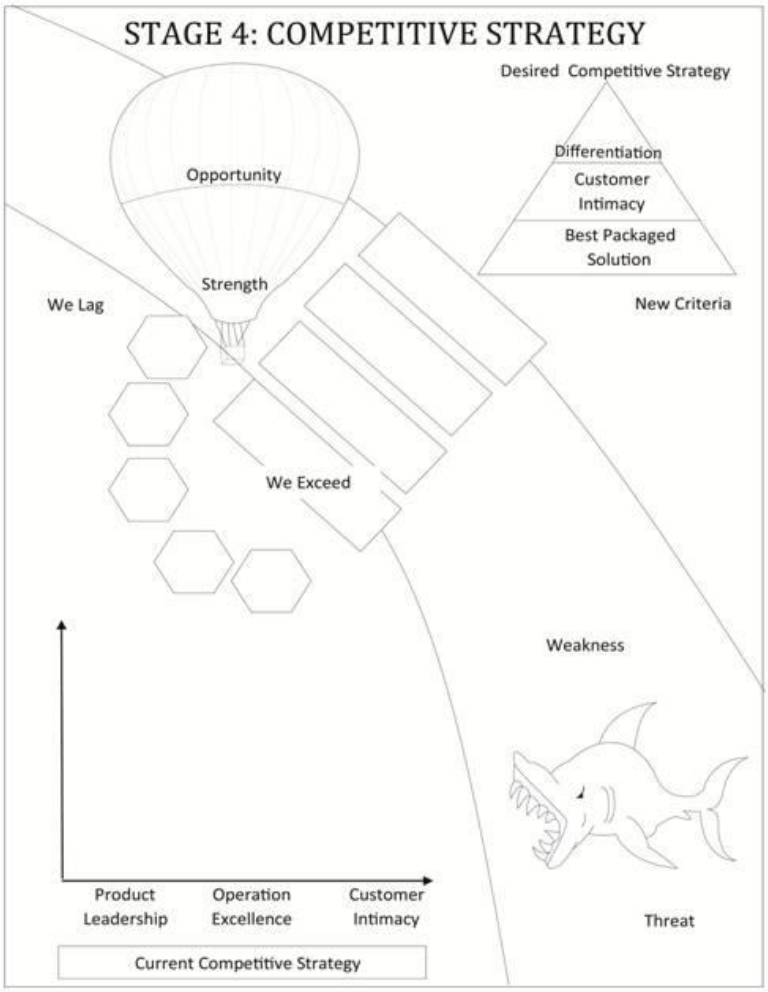
Part 4

PSSE Facilitation Chart

Facilitation Chart 4: Review Competitive Strategy



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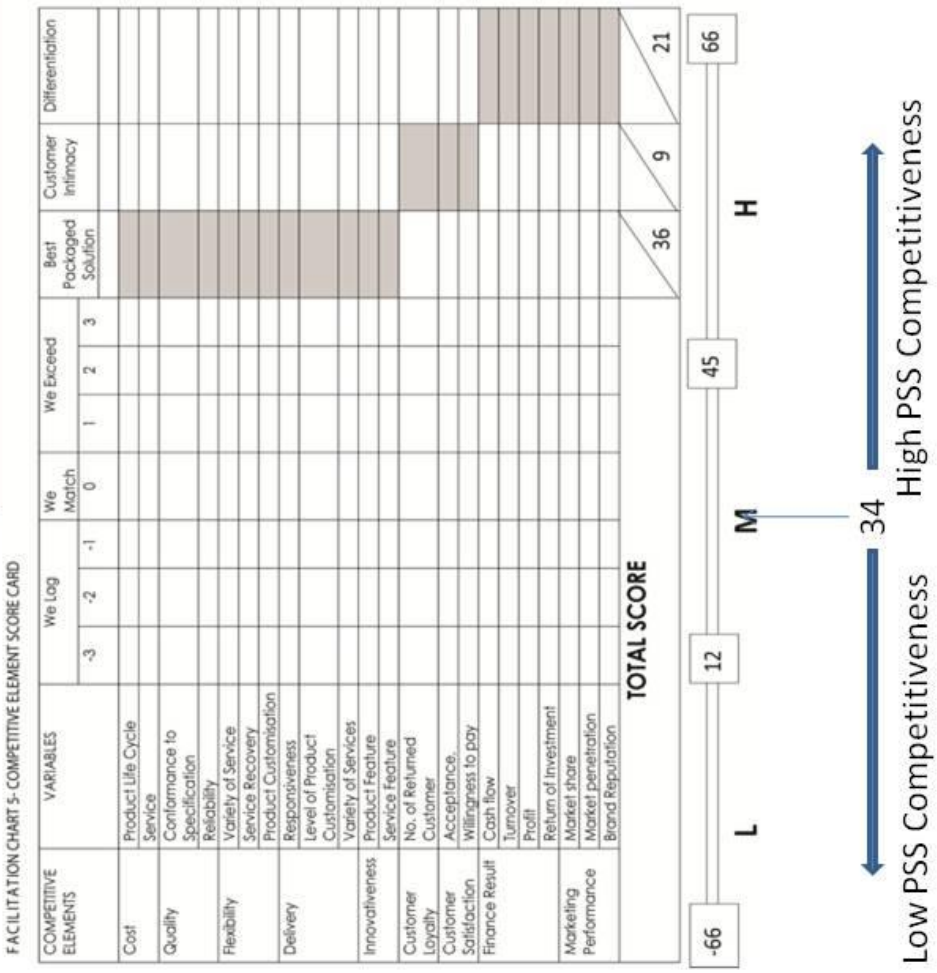
Part 4

PSSE Facilitation Chart

Facilitation Chart 5: PSS Competitive Elements Measurement Chart (PSS-CMC)



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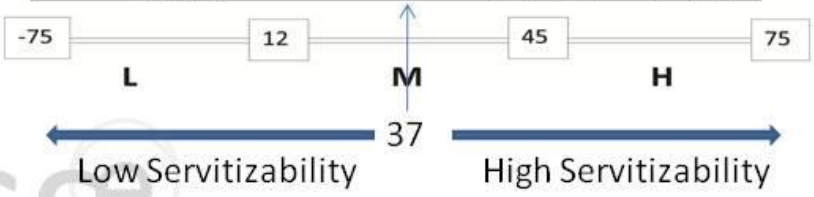
Part 3

PSSE Facilitation Chart

Facilitation Chart 6: PSS Servitizability Measurement Chart (PSS-SMC)

Manufacturing Policy Areas	Assessment Questions	No			Don't know / N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							
	Do you have the right process and technology to produce customised service as required by the new PSS?							
	Does your R&D department capable in design product with features to support the new PSS?							
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point" and flexible demands from the customer in term of special feature of product and service?							
Facilities - factory size, location etc.	Do you have a service department?							
	Are you able to replace faulty unit within acceptable time required by customer?							
	Is your factory repair unit physical close to the customer's site?							
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?							
	Is your supplier able to support you in the new PSS operation, i.e. product take back or part replacement?							
Planning and Control	Are you able guarantee product and service availability to your customer?							
	Is your company recognised as a provider of best total solution?							
Span of process	Is your process service-oriented?							
	Do you have standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide good service to them?							
	Do you have the right skilful service staff to deliver the promised service?							
Quality Control	Can you deliver the services that meet customer's specification?							
	Can you product deliver the promised service and functionality?							
Product / Service Range	Do your have the suitable product to support the new PSS?							
	Are you able to provide services exactly what the customer wanted?							
	Do you have the responsiveness to provide prompt service?							
	Are you able to solve client's problems and attend to much broader range of customer's need?							
	Do you have deep customer knowledge and insights about your customer's underlying process?							
New PSS Introduction	Do you have a finance/billing system support the new PSS operation?							
	Does your product possess features to monitor the real time usage and health check of the new PSS operation?							
	Are the new services you intend to provide inimitable?							



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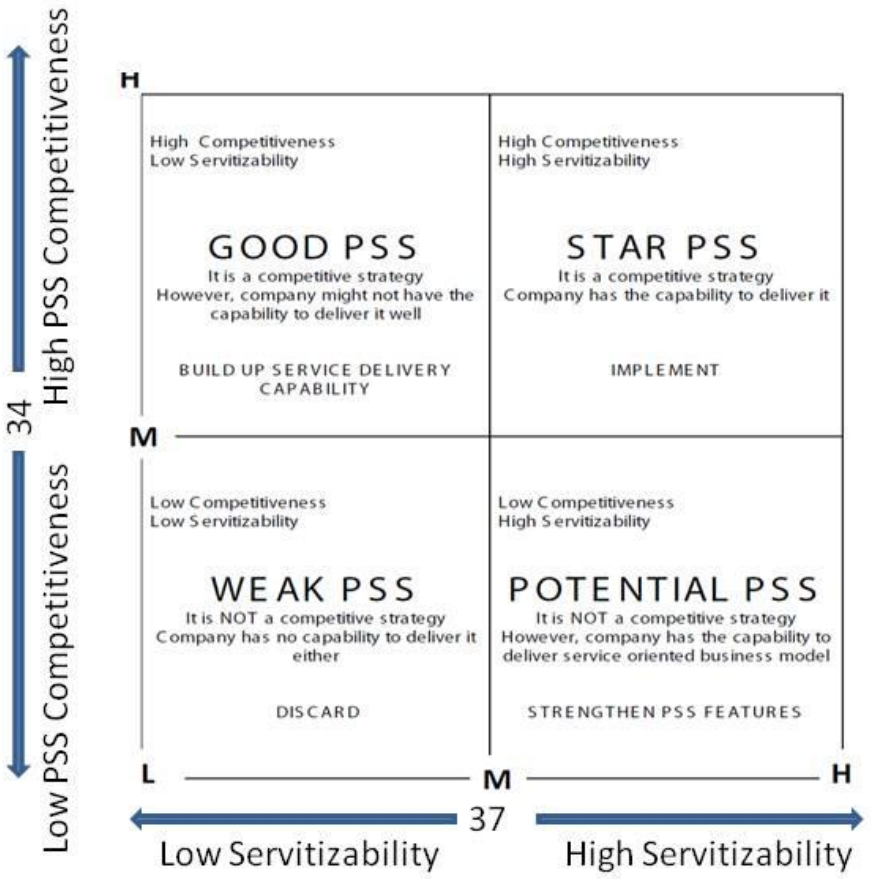
Part 4

PSSE Facilitation Chart

Facilitation Chart 7: PSS Strategy Competitiveness Assessment Matrix



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Part 5

PSSE Work Sheet

Work Sheet 1.1: Servitization Task Force Members

Role	Responsibilities	Typical Position	Name & Designation
Task force Leader	✓To organise team members to prepare resources required for the discussion ✓To ensure discussion process carried out smoothly between workshops ✓To champion recommendation made through the decision process	Senior management member	
Financial Experts	✓To provide input pertaining to the financial aspects of the company and product/service sales	Finance director or accountant	
Customer Interface	✓To provide knowledge and input pertaining to customer facing activities	Marketing / Business director or manager	
Manufacturing Experts	✓To provide information pertaining to the manufacturing of products	Operation/ Production director or manager	
Infrastructure Experts	✓To provide knowledgeable and experienced input pertaining to the infrastructure of the company	IT manager	
Product Experts	✓To provide knowledgeable and knowhow on the existing and new features of the products	Technical / R&D / Manufacturing director or manager	
Service Experts	✓To provide knowledgeable and experienced input on the operation of the existing services ✓To provide input pertaining to the design of the new services	After sales support team members	
Note taker	✓To document the result of the discussion in each stage onto the work sheets provided ✓To capture information on the post in notes on the facilitating chart	Administrative staff or junior technical staff	

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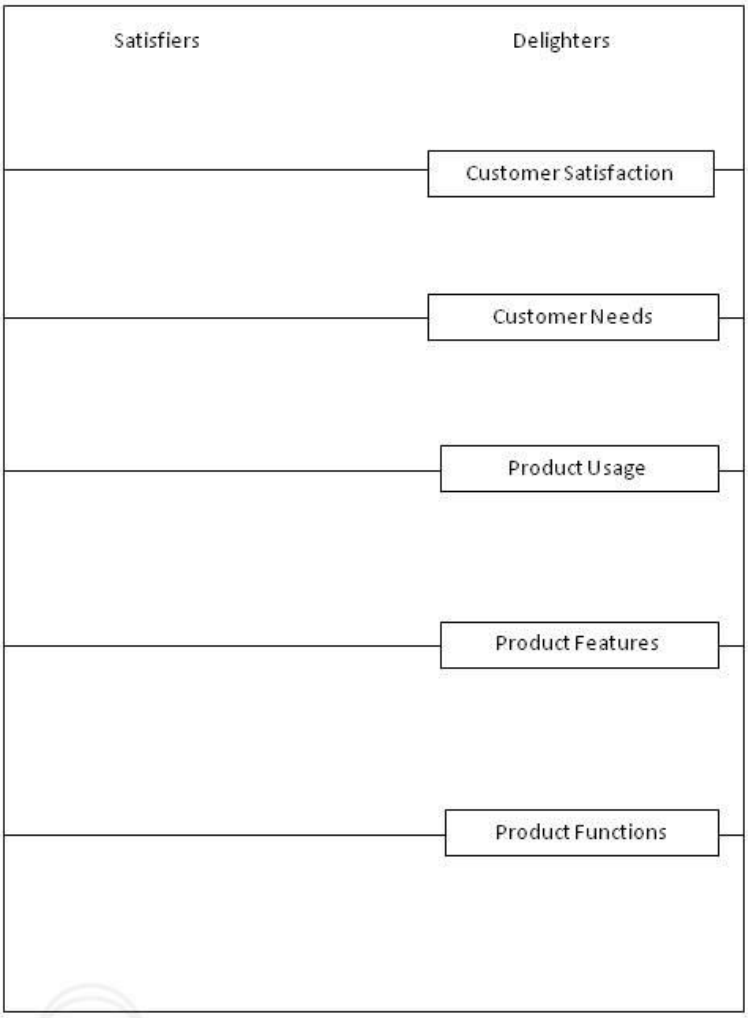
Part 5

PSSE Work Sheet

Work Sheet 2.1: Understanding Customer's Needs



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Part 5

PSSE Work Sheet

Work Sheet 2.2: Potential PSS Services

				Service Delivery System		
No.	**Service**	**Description**		**Department**	**Delivered by**	**Charging System**
			E			
			E			
			E			
			E			
			E			
			E			

SERVICE TYPE:

SSP – Service Supporting Product ☐

SSC – Service Supporting Customer ☐

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Part 5

PSSE Work Sheet

Work Sheet 3.1: Design New Activities for PSS

Origin of Product	
Manufacturing Facilities	
Manufacturing Activities	
Quality Control	
Finished Product	
Marketing	
Sales	
Admin	
Service	
Delivery of Services	

New PSS Activities

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Part 5

PSSE Work Sheet

Work Sheet 3.2: Identify Critical Resources for New PSS

	PSS Activities	Measures					Critical Resources
Resources		Sup	I	D	Sub	A	
Physical							
Financial							
Human							
Technological							
Organisational							
Reputation							

Sup – Superiority; I – Imitability; D – Durability; Sub – Substitutability; A – Appropriability

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Part 5

PSSE Work Sheet

Work Sheet 3.2: Identify Critical Resources for New PSS

Additional Information for Worksheet 3.2

Superiority
Evaluates if and to what extent the resource contributes to differentiating the company from its competitors
*Scale : **1** (Low value) <> **5** (High value)*

Imitability
Analyses actual and potential competitors' difficulty in imitating the resource, e.g., its physical uniqueness, path dependency, casual ambiguity or economic deterrence
*Scale: **1** (Easy to imitate) <> **5** (Difficult to imitate)*

Durability
Measures if the resource's benefits will also be generated in the long term
*Scale: **1** (Short life span) <> **5** (Long life span)*

Substitutability
Assesses how difficult it is for competitors to replace the resource with an alternative that gives the same advantages
*Scale: **1** (Easy to replace) <> **5** (Difficult to replace)*

Appropriability
Verifies if the company owning the resource is able to exploit the generated advantages generated in the market
*Scale: **1** (Lesser portion of market profit) <> **5** (Higher portion of market profit)*

(Adopted from Lim, 2007)

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Part 5

PSSE Work Sheet

Work Sheet 3.3: Identify Critical Success Factors

PSS Activities	Critical Success Factor

- Cost of investment ☐
- Cost of maintenance ☐
- Customer Acceptance ☐
- Service Design ☐
- Product Take back ☐
- Others ☐

The PSSE Facilitator's Guide 2010

Part 5

PSSE Work Sheet

Work Sheet 4.1: SWOT Analysis

STRENGTH	WEAKNESS
OPPORTUNITY	THREAT

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Part 5

PSSE Work Sheet

Work Sheet 4.2: Review Current Competitive Strategy

Part I

Statement	Agree	Dis-agree	Don't Know
1. Our services provide exactly what our customers need			
2. Our core processes are client acquisition and development, and solution development			
3. We are intolerant to error, mistakes, and poor quality and provide zero defect service to our customers			
4. We win the market through great products and invent, develop, and market – fast			
5. Important improvement levers for us are process redesign and continuous improvement			
6. Our company is recognised as a provider of best total solution – provide better overall result for the clients than anyone else			
7. We target our R & D towards development of devices that are smaller, faster, lighter, cooler, cheaper and whatever constitutes better performance than those existing			
8. A customer is not dependent on us we dependent on him, customer satisfaction is the first thing			
9. We provide swift delivery and dependable service			
10. Our employees jobs are structured around the creation of products, not around any particular function			

The PSSE Facilitator's Guide 2010

Part 5

PSSE Work Sheet

Work Sheet 4.2: Review Current Competitive Strategy

Part II

Statement	Agree	Dis-agree	Don't Know
11. We believe in solving customers broader problem – attend to much broader range of client's need			
12. We are passionate about measuring and monitoring to ensure rigorous quality and cost control			
13. We have compensation systems that reward success and constant product innovation is encouraged			
14. We recognise that the company's current success and future prospects lie in its talented product design people and those who support them			
15. We often put ourselves at risk to further our client's success			
16. We actively collect performance feedback from our customers			
17. We provide product reliability, durability, dependability at the lowest total cost			
18. We focus on the core processes of invention, product development, and market exploitation			
19. We have standardised and efficient operating procedures			
20. We have deep customer knowledge and insights about the client's underlying processes			

The PSSE Facilitator's Guide 2010

Part 5

PSSE Work Sheet

Work Sheet 4.2: Review Current Competitive Strategy

Part III

Statement	Agree	Dis-agree	Don't Know
21. Being creative is most important for us & we are trend setters and pioneers in the products we create			
22. Our company is recognised as a provider of best total cost			
23. We try to minimise our distribution and transportation costs			
24. We have the responsiveness-willingness to help customers and provide prompt service			
25. In our company the team is what counts not the individual			
26 Our company is recognised as a provider of leading products & we produce a continuous stream of state-of-art products and services			
27. We understand how changes to our service offer will benefit our customers			
28. We avoid variety in products and maintain a very narrow product line.			
29. We recognise the need to educate and lead the market regarding the use and benefits of new and innovative products			
30. We believe in retiring (making obsolete) our own products before our competitors do			

The PSSE Facilitator's Guide 2010

Part 4

PSSE Work Sheet

Work Sheet 4.3: Score Card for Competitive Strategy Review

No.	Strategy Indicator	Current Competitive Strategy	Desired Competitive Strategy
1	C		
2	C		
3	O		
4	P		
5	O		
6	O		
7	P		
8	C		
9	O		
10	P		
11	C		
12	O		
13	P		
14	P		
15	C		
16	C		
17	P		
18	P		
19	O		
20	C		
21	P		
22	O		
23	O		
24	C		
25	O		
26	P		
27	C		
28	O		
29	P		
30	P		

C -- Customer Intimacy Excellence | P -- Product Leadership | O - Operation

Current Competitive Strategy	No. of Cs		No. of Ps		No. of Os	

The PSSE Facilitator's Guide 2010

Part 4

PSSE Work Sheet

Work Sheet 5.1: PSS Competitive Elements Measurement Chart (PSS-CMC)

Competitive Elements	Variables	We Lag			We Match	We Exceed			Best Packaged Solution	Customer Intimacy	Differentia-tion
		-3	-2	-1	0	1	2	3			
Cost	PSS Package Price										
	Service / Product										
Quality	Conformance to Specification										
	Reliability										
Flexibility	Variety of Service										
	Service Recovery										
	Product Customisation										
Delivery	Responsiveness										
	Level of -Service Customisation										
	Variety of Services										
Innovative-ness	Product Feature										
	Service Feature										
Customer Acceptance	No.of Returned Customer										
Customer Satisfaction	Acceptance										
	Willingness to pay										
Finance Result	Cash flow										
	Turnover										
	Profit										
	Return of Investment										
Marketing Performance	Market share										
	Market penetration										
	Brand Reputation										

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Low PSS Competitiveness ← → High PSS Competitiveness

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The PSSE Facilitator's Guide 2010

Part 5

PSSE Work Sheet

Work Sheet 6.1: PSS Servitizability Measurement Chart (PSS-SMC)

Part I

Manufacturing Policy Areas	Assessment Questions	No			Don't know N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							
	Do you have the right process and technology to produce customised service as required by the new PSS?							
	Does your R&D department capable in design product with features to support the new PSS?							
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point "and flexible demands from the customer in term of special feature of product and service?							
Facilities - factory size, location etc.	Do you have a service department?							
	Are you able to replace faulty unit within acceptable time required by customer?							
	Is your factory repair unit physical close to the customer's site?							
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?							
	Is your supplier able to support you in the new PSS operation, i.e. product take back or part replacement?							
Planning and Control	Are you able guarantee product and service availability to your customer?							
	Is your company recognised as a provider of best total solution?							

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Part 5

PSSE Work Sheet

Work Sheet 6.1: PSS Servitizability Measurement Chart (PSS-SMC)

Part II

Manufacturing Policy Areas	Assessment Questions	No			Don't know / N.A	Yes		
		-3	-2	-1	0	1	2	3
Span of process	Is your process service-oriented?							
	Do you have standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide good service to them?							
	Do you have the right skilful service staff to deliver the promised service?							
Quality Control	Can you deliver the services that meet customer's specification?							
	Can you product deliver the promised service and functionality?							
Product/ Service Range	Do you have the suitable product to support the new PSS?							
	Are you able to provide services exactly what the customer wanted?							
	Do you have the responsiveness to provide prompt service?							
	Are you able to solve client's problems and attend to much broader range of customer's need?							
	Do you have deep customer knowledge and insights about your customer's underlying process?							
New PSS Introduction	Do you have a finance/billing system support the new PSS operation?							
	Does your product possess features to monitor the real time usage and health check of the new PSS operation?							
	Are the new services you intend to provide inimitable?							

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Low Servitizability — High Servitizability

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The PSSE Facilitator's Guide 2010

Part 5

PSSE Work Sheet

Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED		
LEVEL OF PSS COMPETITIVENSS	L	H
LEVEL OF SERVITIZABILITY	L	H
TYPE OF PSS STRATEGY AFTER ASSESSMENT	GOOD PSS WEAK PSS	STAR PSS POTENTIAL PSS
CRTICAL RESOURCES REQUIRED TO IMPLEMENT NEW PSS STRATEGY		
FUTURE ACTION		

Part 6

Reference

Ang, J., Baines, T. & Lightfoot, H. (2010), "A methodology for adopting PSS as a competitive strategy for manufacturer", *CIRP Conference 2010*, Sweden

Baines, T., Lightfoot, H., Evans, S., Neely, A., Greenough, R., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J., Angus, J., Basti, M., Cousens, A., Irving, P., Johnson, M., Kingston, J., Lockett, H., Martinez, V., Michele, P., Tranfield, D., Walton, J. and Wilson, H. (2007), "The state-of-the-art of product service systems", Proceedings of the I MECH E Part B, *Journal of Engineering Manufacture*, vol.221, no.10, pp. 1543-1552

Baines, T. & Lightfoot, H. (2007), "Product Service Systems as a service based competitive strategy", Cranfield University

APPENDIX C: CASE STUDY

[Examples of the usage of worksheets and facilitation charts only provide in case S1]

CASE STUDY P1 | WATER HEATER CO.

Case Study's Report Water Heater co.

P1

Introduction

Water Heater Co. is the first water heater company in Singapore. The company was founded in 1989. This company designs, manufactures, distributes and sells electrical instant water heaters. As the water heaters became commoditized and the sales getting stagnant, the company has intention to provide more services to maintain its competitiveness. Since it is the first water heater company in Singapore, it has a huge installed base and the older generation preferred brand of water heater. Apart from eyeing at the huge replacement market, the company is considering to re-structure its service unit to turn it into a profit making business unit rather than the current supporting non-profit generating unit. The company is currently working with the housing developer to look into providing total solution is providing centralising heating services for swimming pool, washing and showering etc. too.

Stage 1: Scope Issue and Exploring Opportunity

The core competency of the company is its capability and know how in developing instantaneous electric water heaters. It is one of the first Asia water heater manufacturers that have obtained the British BE marking for water heaters and has a large distribution network in South East Asia. The overriding problems identified are that the sales of the water heater are becoming stagnant, and the profit margin is too small to continue to sustain the operation of the business. There are occasions that the company has to close sales at no profit just to keep the production running. Current competitive strategy identified is Product Leadership as the company constantly rolls out new water heater model and perform face life to its existing water heater range to keep its business. The company has identified the new multi-point water heater MP2 as the potential product for selling as a PSS.

Case Study's Report Water Heater co.

P1

2

Multi-point Heater

Stage 2: Identify Servitization Landscape

The new PSS services mainly targeted at replacing the existing old water heater with the new multi-point water heater for the customer through leasing, instalment, or selling "hot water per usage". Most of the existing old water heater owners and users are old people. They have strong brand loyalty and always wanted the same brand of water heater or even asking for same discontinued old models to replace their existing old heater.

Drivers
1st Water heater manufacturing in Singapore
Big customer base in Singapore
Reputable brand
Strong know-how in churning out new products within a short period of time

Service / Customer's Needs
hot water that is convenient and affordable
Safe product features
Easy to use features for old people

Barriers
Strict certification and regulation because it is high power's product
Service men mindset need to change
Customer service need to be improved
Current staff are not used to selling service

Case Study's Report Water Heater co.

P1

3

Stage 3: Design PSS

The multi-point heater MP2 has to be modified to include new feature for tracking of the usage of the hot water when it is to be used in a PSS. The company existing service and marketing team can double up as the sales and service team for the new PSS. New PSS activities identified include new contract template for selling the availability of the hot water, new costing and billing model, product modification, product installation, product maintenance, product take back and part replacement etc.

Customer Satisfaction
Safe hot water

Customer Needs
Satisfiers
Easy to use
Reliability
Safe
Temperature setting memory feature

Delighters
Hot water with massaging function
High flow rate with low power consumption

Case Study's Report Water Heater co.

P1

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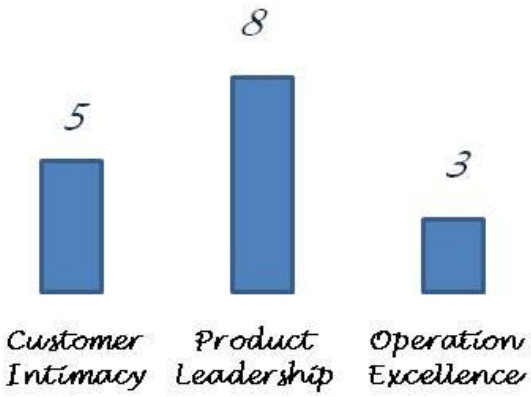
Stage 4: Review Competitive Strategy

The most critical success factor identified is Cost of Investment. The company currently is in a very critical financial situation. Any investment involved in new business set up has to be carefully assessed and justified. As the new PSS involves huge initial set up cost (for example, free installation and replacement of old single point water heater with new multi point water etc), and do not foresee to breakeven within a year, the chance is that if the company does not have enough fund to sustain the operation, the new PSS will be not able to implement long enough to reap its potential profit. The second critical success factor identified is Customer Acceptance as majority of their current existing clients are users who are above 50 years old. Any new business model would have to be able to bring forth immediate benefits to this group of users in order to convince to switch to a new PSS. Current competitive strategy assessed as product leadership as the company has been in this business since 1969 and constantly launch new water heaters into the market.



Case Study's Report Water Heater co.

P1

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Stage 5: Assess PSS Competitiveness and Servitizability

The overall PSS competitive elements are assessed to be slightly below average. In the category of best package and customer intimacy, the company is leading its competitor as it has the strong brand name, recognised product image and a wide user base. However in term of differentiation, it was assessed as being average as the company currently is not performing well financially plus the new PSS business model will take a long time (at least 2 years by estimation) to maintain before the company can reap its promised financial benefit.

PSS Competitive Elements Score <=0 (we lag):
Flexibility, Quality, Finance Performance, Marketing Performance

PSS Competitive Elements Score >=0 (we exceed):
Cost, Delivery, Innovativeness, Customer Satisfaction
Quality, Innovativeness, Cost, Flexibility, Delivery,
Customer Satisfaction, Customer Acceptance,

Overall PSS Competitiveness Score:
Best Packaged Solutions: 24
Customer Intimacy: 8
Differentiation: -2
Overall Score: 45%

Case Study's Report Water Heater co.

P1

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Best Packaged Solution	24	66%
Customer Intimacy	8	88%
Differentiation	-2	-10%
Overall Score	30	45%
PSS Competitiveness	LOW	

Stage 5: Assess PSS Competitiveness and Servitizability

Servitizability is rated slightly below average. Although the company has existing installation, repair and customer service personnel, they are not equipped with the right mind set to service customer in providing good service. The production facilities and process are slim, labour intensive and high-mix-low-volume oriented, as a result, it can be re-scheduled easily to produce the new heater for PSS too. Although the company does not have its own R&D unit it has been closely using the local research institute as one of its R&D arm. Both structure and infra-structure policies can be adjusted to adapt easily to provide the service delivery system for the new PSS, thus in term of Servitizability, the company has its edge to transform easily to support a new business model.

Manufacturing Policy Areas <=0 (not ready):
Capacity, Planning and Control, Flexibility

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Span of Process, Human Resource, Quality Control, Supply Chain Positioning, Planning and Control, Product/Service Range, New PSS Introduction

Overall Servitizability Score:
Structure [redacted] 10
Infrastructure: [redacted] 23
Overall Score: 45%

Case Study's Report Water Heater co.

P1

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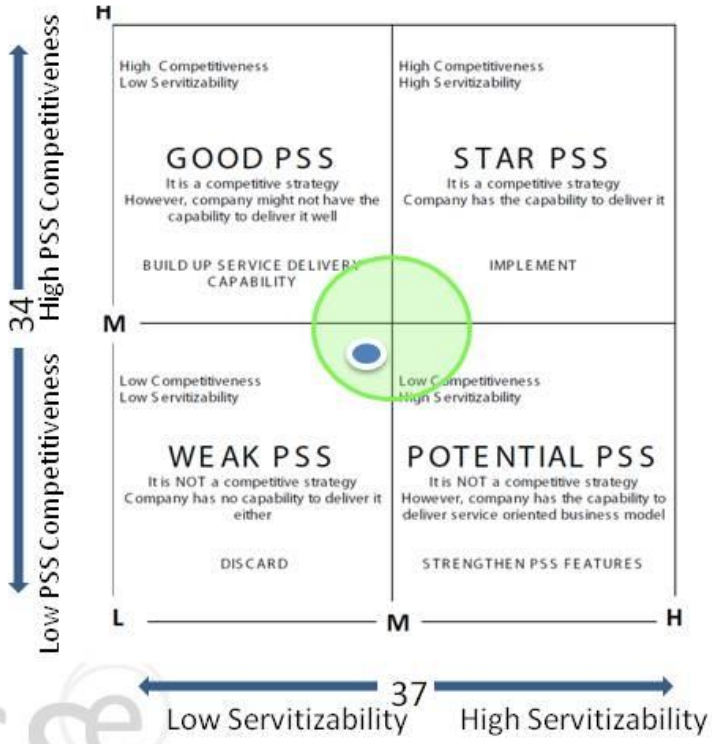
Structure	10	38%
Infrastructure	23	58%
OverallScore	33	45%
Servitizability	Low	

Stage 6: Consolidate Outcome and Generate Score Card

Stage 6 of the PSSE methodology performs the Servitizability of the company in term of its structure and infra-structure policy areas. The company scored high in manufacturing areas such as Process and Technology, Span of Process, Human Resource and Product Service Range. However, it needs improvement in areas such as Supply Chain Positioning, Facilities and Planning and Control which have scored negative marks during the assessment. The overall Servitizability of the company has been assessed to be Low with an average score of 44.

Level of PSS Competitiveness: Low: 30
Level of Servitizability of Company: Low: 33



Case Study's Report Water Heater co.

P1

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Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	*Result Oriented PSS in unit of hot water to commercial clients by using the multi-point heater.*
LEVEL OF PSS COMPETITIVENSS	**L** (circled) **H**
LEVEL OF SERVITIZABILITY	**L** (circled) **H**
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** **STAR PSS** **WEAK PSS** (circled) **POTENTIAL PSS**
FUTURE ACTION	✓ *To improve on the finance performance and market penetration.* ✓ *To set up new service department to handle profitable services* ✓ *To enhance on the features of the multi-point water in order to support the new PSS concept*

The proposed PSS is identified as a WEAK PSS. However, as the score is rather close to the dividing points, a few more points or a change of the dividing points will put this new strategy as a STAR PSS. As shown in the Figure above, the middle circle represent areas that a PSS can be assessed into different types of the competitive strategy. Recommendation is to perform a re-assessment with input from a cross-disciplinary team in order to produce a more truthful result.

CASE STUDY P2 | CAD CAM CONTROLLER CO.

Case Study's Report CAD/CAM Controller Co.

P2

Introduction

CADCAM Controller Co. is one of the world's leading suppliers of advanced CADCAM solutions for manufacturing industry. The South East Asia branch has its head quarter based in Singapore, and provides professional manufacturing processing services to the Aerospace and Medtech industry in Singapore. Although the company participated in the primary evaluation, the proposal put up by the company is not really a true PSS business cases as the product involved in this discussion is not a tangible product but intangible software. Basically the company has the intention to replace the existing business model of selling CAD/CAM controller software license with a provision of a one stop professional solution in improving the productivity of the clients. Although it is not a true PSS case, the company has actively participated in the post workshop assessment of the methodology and have given many valuable inputs especially in the improvement of the structure and facilitation process of the methodology.

Case Study's Report CAD/CAM Controller Co.

P2

2

Stage 1: Scope Issue and Exploring Opportunity

The core competency of the company is its capability and product know-how in CAD/CAM controller and inspection. The reasons of moving towards Servitization is that its products are becoming commoditised. The main overriding problem identified is project management of services due to the transition of the company from a product oriented business sales to a service oriented business model. Project management of selling services becoming challenging when using the existing product management process. The product identified for Servitization is the CAD/CAM adaptive software package.

Multi-point Heater

Case Study's Report CAD/CAM Controller Co.

P2

3

Stage 2: Identify Servitization Landscape

One of the drivers identified in this stage is that the Singapore Government is providing incentives in encouraging manufacturing industry to move to the high end value manufacturing thus resulting in the services provided by the company in high demand. However, the company also encounters problems in closing sales as the local companies in Singapore needs to go through the change of mindset of letting go their current cheap labour intense operations model for highly automated solution. The customer needs identified are productivity, able to reduce the cost of labor, more automation and health improvement for working environment.

Drivers
Singapore Government is encouraging the industry to move to high value manufacturing

Service / Customer's Needs
KPI Improvement
High Productivity
High Automation
Reduce Labor Cost
Better Working Environment

Barriers
Prefer to save money by using cheap labor from neighboring countries to perform the process rather than using software and high end machine

Stage 3: Design PSS

In understanding the customer needs before designing PSS activities, the company has identified the following reasons that will delight the customers: first, currently companies are generally lack of knowledge in how to improve their productivity, they would be delighted if the services provided can transfer knowledge to them; second, if the end solution can help them to save money and decrease dependency on cheap labour from the neighboring countries, they would be delighted too. The PSS activities provided involve setting up the process and project management based on the new PSS. PSS identified to be result oriented PSS is selling professional services using their CAD CAM adaptive software packages to assist company in improving their productivity and automate their tooling process.

Customer Needs
Satisfiers
High Productivity with low investment cost

Delighters
Service provided resulting in the development of new knowledge
End solution provided can result in decreasing the dependency of cheap labor

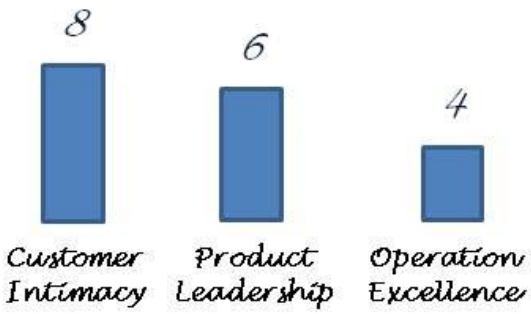
Case Study's Report CAD/CAM Controller Co.

P2

4

Stage 4: Review Competitive Strategy

Current competitive strategy identified is Customer Intimacy as the company constantly providing professional service to the industry. The strengths of the company are that it has wide range of products to support the service, strong R&D and no strong competitors; opportunities are strong demands from the industry and growing demands of the spec of the components; weaknesses identified is that the head quarter in UK is still in the transition from product sales to services sales, as a result the existing process is still very much product oriented and therefore it has resulted in constant conflict in terms of project management between the South East Asia's office and its headquarter.



Case Study's Report CAD/CAM Controller Co.

P2

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Stage 5: Assess PSS Competitiveness and Servitizability

The overall PSS competitive elements are assessed to be high. The company scores well in areas like Quality and Innovativeness. The only competitive element that has a negative score is Flexibility.

PSS Competitive Elements Score <=0 (we lag):
Flexibility

PSS Competitive Elements Score >=0 (we exceed):
Cost, Delivery, Quality, Innovativeness, Customer Satisfaction Quality, Innovativeness, Cost, Flexibility, Delivery, Customer Satisfaction, Customer Acceptance, Finance Performance, Marketing Performance

Overall PSS Competitiveness Score:
Best Packaged Solutions: [redacted] 23
Customer Intimacy: [redacted] 4
Differentiation: [redacted] 11
Overall Score: 57%

Case Study's Report CAD/CAM Controller Co.

P2

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Best Packaged Solution	23	64%
Customer Intimacy	4	44%
Differentiation	11	52%
Overall Score	38	57%
PSS Competitiveness	High	

The PSSe Methodology 2010

Case Study's Report CAD/CAM Controller Co.

P2

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Stage 5: Assess PSS Competitiveness and Servitizability

Servitizability is rated as HIGH as the South East Asia branch has been specifically set up to provide professional services. The company scored high in areas such as Process and Technology, Capacity, Quality Control and Service range etc.

Manufacturing Policy Areas <=0 (not ready):
Facility

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Capacity, Span of Process, Human Resource, Quality Control, Supply Chain Positioning, Planning and Control, Product/Service Range, New PSS Introduction

Overall Servitizability Score:
Structure [redacted] 14
Infrastructure: [redacted] 22
Overall Score: 48%

Structure	14	39%
Infrastructure	22	56%
Overall Score	36	48%
Servitizability	Low	

Case Study's Report CAD/CAM Controller Co.

P2

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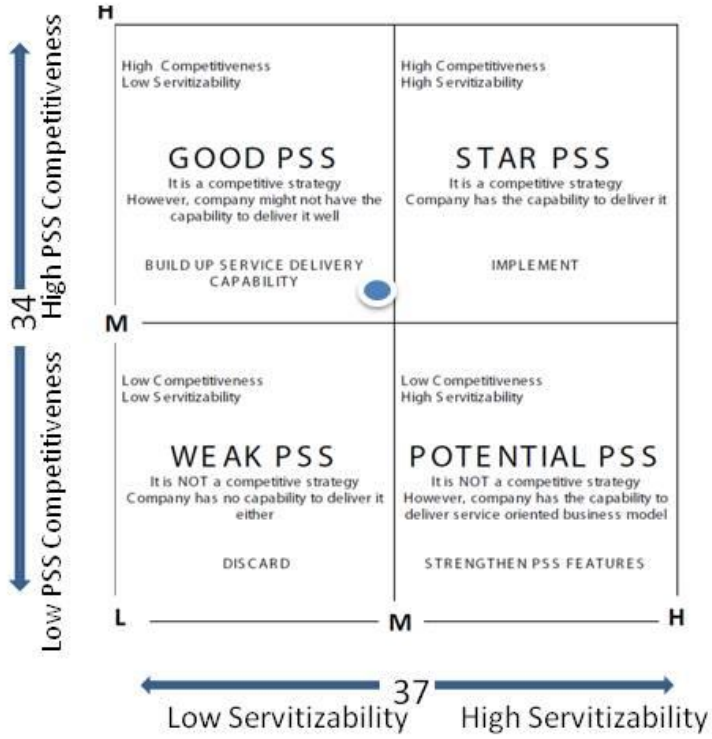
Stage 6: Consolidate Outcome and Generate Score Card

Level of PSS Competitiveness: Low: 30
Level of Servitizability of Company: Low: 33



Case Study's Report CAD/CAM Controller Co.

P2

9

Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	*Result Oriented PSS in delivering the value in use of productivity improvement of client's machines using CAD/CAM adaptive software packages*
LEVEL OF PSS COMPETITIVENSS	**L** **H** (H circled)
LEVEL OF SERVITIZABILITY	**L** (L circled) **H**
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** (circled) **STAR PSS** **WEAK PSS** **POTENTIAL PSS**
FUTURE ACTION	✓ *To improve on the flexibility on the services provided, as currently head quarter is still trying to manage the South East Asia branch with product oriented process thus results in low flexibility in delivering the intended PSS services*

CASE STUDY S1 | Partial Discharge Analyser Co.

Case Study's Report Partial Discharge Analyzer Co.

Introduction

Discharge Analyser Co. is an innovative research based company that specializes in developing new and reliable electrical technologies in the area of partial discharge inspection and testing. It provides an inspection service using Infrared Thermograph technology. They have a strong client base of more than 50 customers from Singapore, Malaysia and China using their services.

Participants:
Mr. Leong, Managing Director
Testing Engineer

Case Study's Report Partial Discharge Analyzer Co.

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Stage 1: Scope Issues

The core competency of the company has been identified as knowledge & experience in condition health monitoring of equipment. The company develops its own partial discharge analyser and holds IP to it. The reasons of moving towards Servitization are to first, to create awareness of its technology and the method used in testing partial discharge and second, to help reducing the customer's cost and third, to provide effective testing in terms of accuracy and reliability. Current overriding problems identified are false claims from competitors (some competitors claimed that they are able to provide similar services too). Product identified for Servitization is the Partial Discharge Analyser which aims to provide equipment health inspection service. The Servitization task force team members took part in the PSSE workshop are:

- Mr Leong – Managing Director, Taskforce Leader
- Testing Engineer

Partial Discharge Analyser

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Stage 2: Identify Servitization Landscape

Stage 2 of the PSSE methodology focuses in understanding the customer needs and identifies drivers and barriers towards Servitization. The drivers identified for moving towards Servitization are vale add and survival. Barriers identified are poor level of customer acceptance, customer lack of knowledge and the market not mature yet. Customer needs have been identified as Safety, Cost Saving and Awareness of the Testing Method. The list of services identified for potential PSS strategy are shown in the Table below:

Product-Oriented PSS	Result-Oriented PSS
Warranty	Infra-redtesting
Training	Partial dischargetesting
Customisation Support	Vibration analysistesting
	Power Quality testing

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Stage 3: Design PSS

Stage 3 of the PSSE methodology involves understanding customer's needs and designs the PSS activities to support the services identified in Stage 2. Potential applications and market segments identified are Transformers, Generators, Motors, Switch Gears, Power Plant, Oil & Gas Industrial Areas (High Voltage Machines), Nuclear Plant and Oil Rigs. Customer's needs can be divided into satisfiers and delighters. Satisfiers identified in this stage are Inspection results. Delighters identified are the ability to help customers to reduce the cost for maintenance and, once the problem was detected during the testing, help them to solve it. Product features required in delivering the customers' satisfiers and delighters are user friendly, user Interface and test report, as well as the product used in providing the testing must be lightweight and portable.

New PSS activities identified are Service Contract to deliver Result Oriented PSS and Testing per equipment.

New PSS activities:

Service Contract - Result Oriented PSS
Testing per equipment

The PSSe Methodology 2010

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Stage 4: Review Competitive Strategy

Stage 4 of the PSSE methodology first performs the SWOT analysis. Strengths identified high reliability, low Cost and experience; Opportunities are overseas new untouched markets and black-out; Weakness are Lack of skilful staff and funding, and product must meet safety requirements; Threats are too many false claims and competitors selling at low costs. The company exceeds their competitors in terms of reliability and accuracy, however lagging behind in terms of lack of production line to churn out equipments fast enough should the demand surges. Current competitive strategy assessed to be Operation Excellence and Customer Intimacy, with the following scores produced

Customer Intimacy	8	89%
Product Leadership	8	73%
Operation Excellence	9	90%
Current Competitive Strategy	Operation Excellence & Customer Intimacy	

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Stage 5: Assess PSS Competitive Elements

Partial Discharge Analyser performs well in this stage. All the PSS competitive elements assessed score a positive mark. In the category of Best Packages Solutions, variables such as *PSS Package Price*, *Conformance to Specification*, *Reliability*, *Variety of Service*, *Product Customisation*, *Level of Service Customisation* and *Product Features* are all rated full marks by the Managing Director. In the aspect of Differentiation, variables such as *Market Penetration* and *Brand Reputation* scored full marks as well. As a result, the competitiveness of the PSS elements has been assessed to be in the range of High with an average score of 53/66 which is 80% in terms of overall PSS competitiveness.

PSS Competitive Elements Score <=0 (we lag):
NIL

PSS Competitive Elements Score >=0 (we exceed):
Cost, Flexibility, Delivery, Customer Satisfaction Quality, Innovativeness, Cost, Flexibility, Delivery, Customer Satisfaction, Customer Acceptance, Finance Performance, Marketing Performance

Overall PSS Competitiveness Score:
Best Packaged Solutions: [redacted] 32
Customer Intimacy: [redacted] 5
Differentiation: [redacted] 16

Best Packaged Solution	32	89%
Customer Intimacy	5	56%
Differentiation	16	76%
Overall Score	53/66	80%
PSS Competitiveness	HIGH	

The PSSe Methodology 2010

Stage 6: Assess Servitizability of Company

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Stage 6 of the PSSE methodology performs the Servitizability of the company in term of its structure and infra-structure policy areas. The company scored high in all the manufacturing areas both structurally and infrastructurally. The only area that needs improvement is Capacity which has scored a "0". The overall Servitizability of the company has been assessed to be in the range of low High with an average score of 53.

Manufacturing Policy Areas <=0 (not ready):
Capacity

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Facilities, Span of Process, Human Resource, Quality Control, Supply Chain Positioning, Planning and Control, Product/Service Range, New PSS Introduction

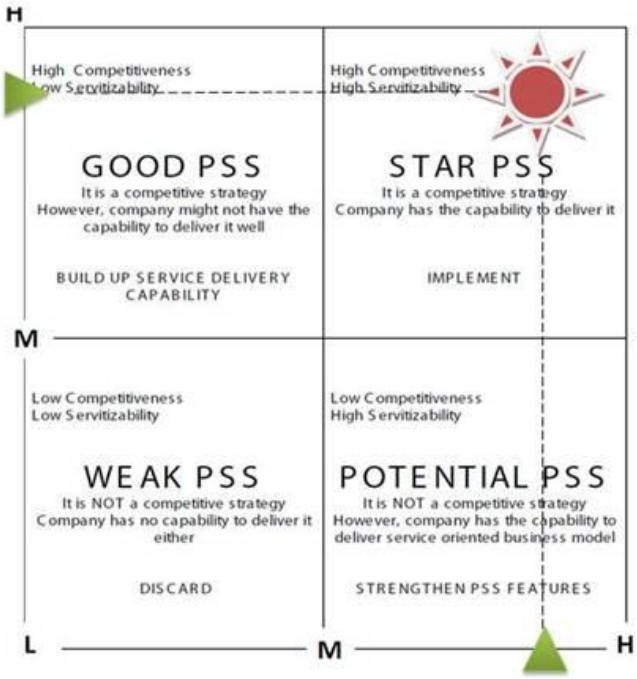
Overall Servitizability Score:
Structure [redacted] 23
Infrastructure: [redacted] 30

Structure	23	59%
Infrastructure	30	83%
OverallScore	53	71%
Servitizability	HIGH	

The PSSe Methodology 2010

Stage 7: Determine Type of PSS Strategy

The last stage of the PSSE methodology consolidates the outcomes and generates the final PSS competitiveness score card by using the PSS Competitiveness Assessment Matrix (PSS-CAM). The final results produced for Partial Discharge Analyser Co. as follows:



The proposed PSS strategy is identified as a good PSS competitive strategy. It is classified under the STAR PSS quadrant as the company possesses strong capability in delivery the new PSS strategy and the new PSS model consists of a high no. Of PSS competitive elements.

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Appendices: Facilitation Charts and Worksheets

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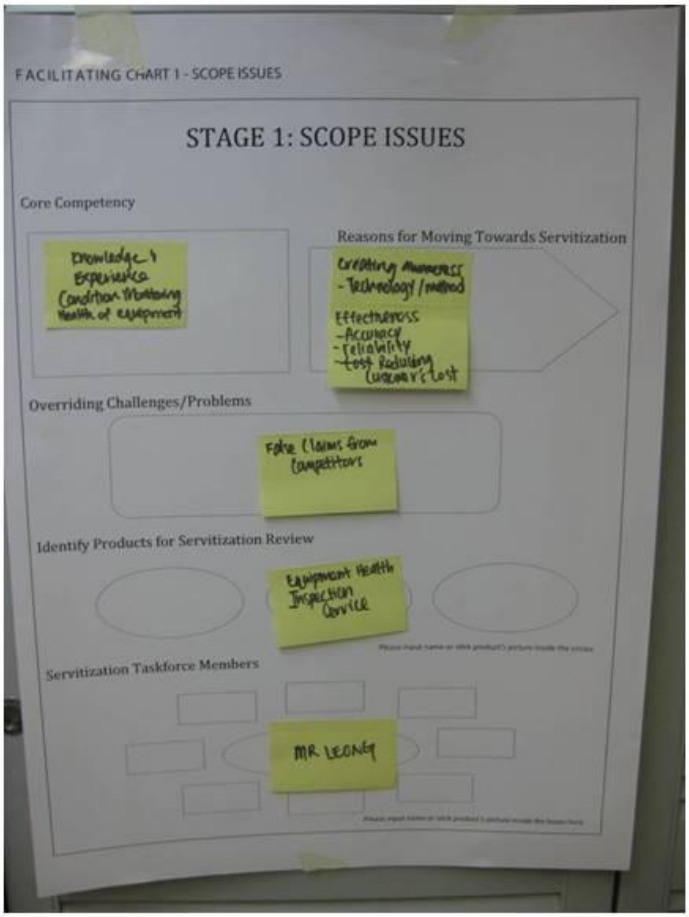
Stage 1: Scope Issues



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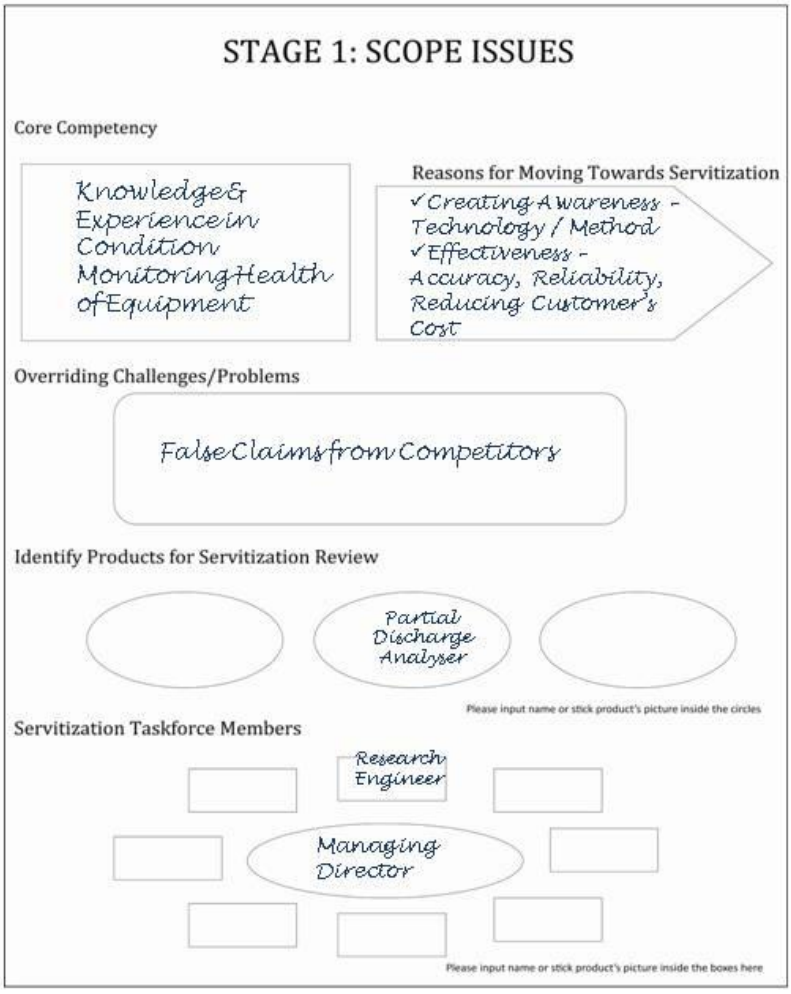
Stage 1: Scope Issues



Stage 1: Scope Issues

Work Sheet 1.1: Servitization Task Force Members

Role	Responsibilities	Typical Position	Name & Designation
Task force Leader	✓To organise team members to prepare resources required for the discussion ✓To ensure discussion process carried out smoothly between workshops ✓To champion recommendation made through the decision process	Senior management member	Mr. Leong, Managing Director
Financial Experts	✓To provide input pertaining to the financial aspects of the company and product/service sales	Finance director or accountant	Mr. Leong, Managing Director
Customer Interface	✓To provide knowledge and input pertaining to customer facing activities	Marketing / Business director or manager	Testing Engineer
Manufacturing Experts	✓To provide information pertaining to the manufacturing of products	Operation/ Production director or manager	Mr. Leong, Managing Director
Infrastructure Experts	✓To provide knowledgeable and experienced input pertaining to the infrastructure of the company	IT manager	Testing Engineer
Product Experts	✓To provide knowledgeable and knowhow on the existing and new features of the products	Technical / R&D / Manufacturing director or manager	Mr. Leong, Managing Director
Service Experts	✓To provide knowledgeable and experienced input on the operation of the existing services ✓To provide input pertaining to the design of the new services	After sales support team members	Testing Engineer
Note taker	✓To document the result of the discussion in each stage onto the worksheets provided ✓To capture information on the post in notes on the facilitating chart	Administrative staff or junior technical staff	Student

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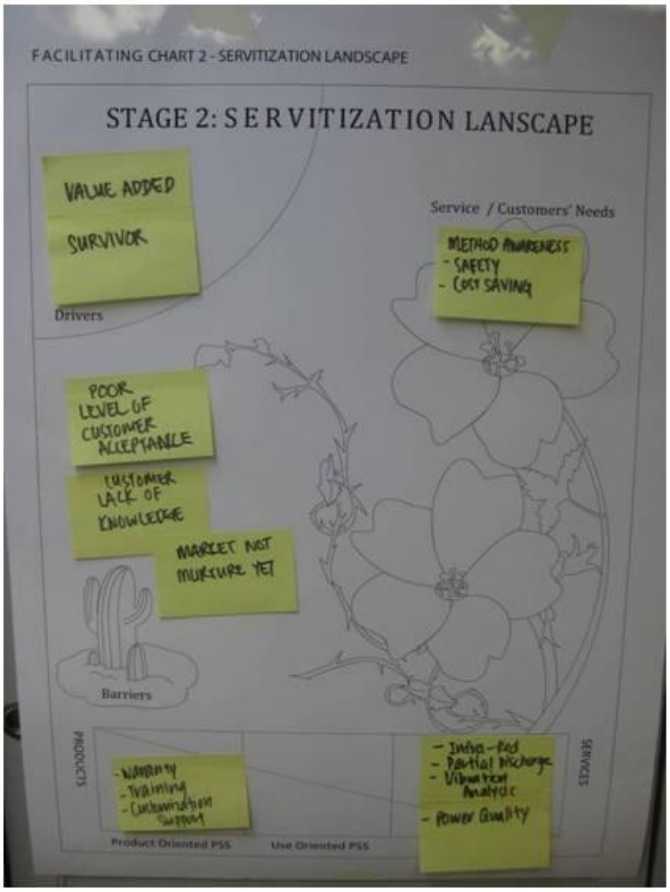
Stage 2: Identify Servitization Landscape



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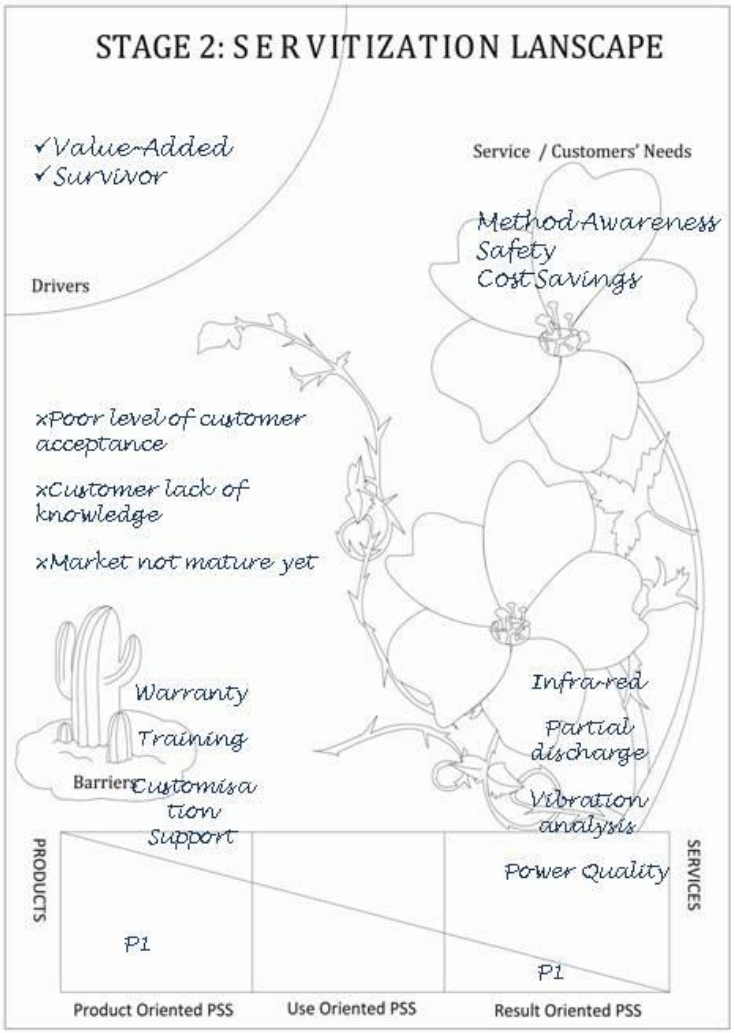
Stage 2: Identify Servitization Landscape



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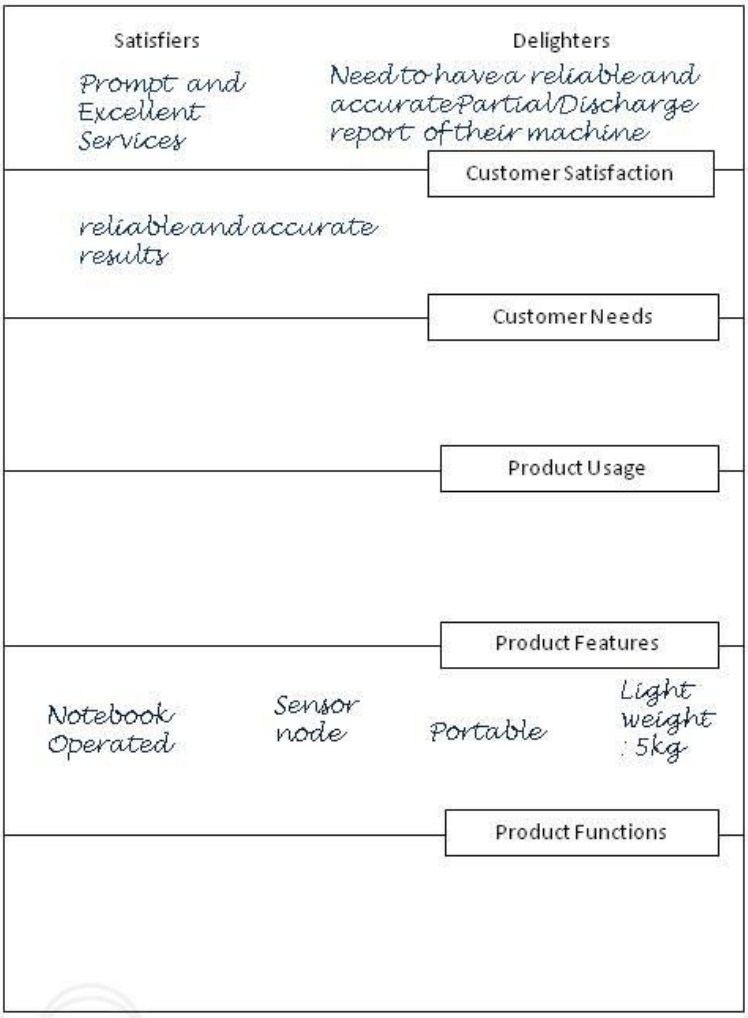
Stage 2: Identify Servitization Landscape

Work Sheet 2.1: Understanding Customer's Needs



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Stage 2: Identify Servitization Landscape

Work Sheet 2.2: Potential PSS Services

				Service Delivery System		
No.	**Service**	**Description**		**Department**	**Delivered by**	**Charging System**
SSP1	Warranty	Warranty provided for supporting the operation of the new product; Standard one year FOC warranty for all partial discharge analyser sold	E	Service Department	Service Technician	FOC for the first year
SSP2	Repair	Service provided for supporting the operation of the installed product	E	Service Department	Service Technician	Transport cost + standard service charge + part cost
SSC1	Training for Proficiency Certification	Service provided to train distributor and freelance installer about the knowledge of products and certification	E	Service Department		Part of the Service Contract
SSC2	Testing of partial discharge per equipment		E	Service Department	Testing Engineer	Per equipment tested

SERVICE TYPE:

SSP – Service Supporting Product ☐

SSC – Service Supporting Customer ☐

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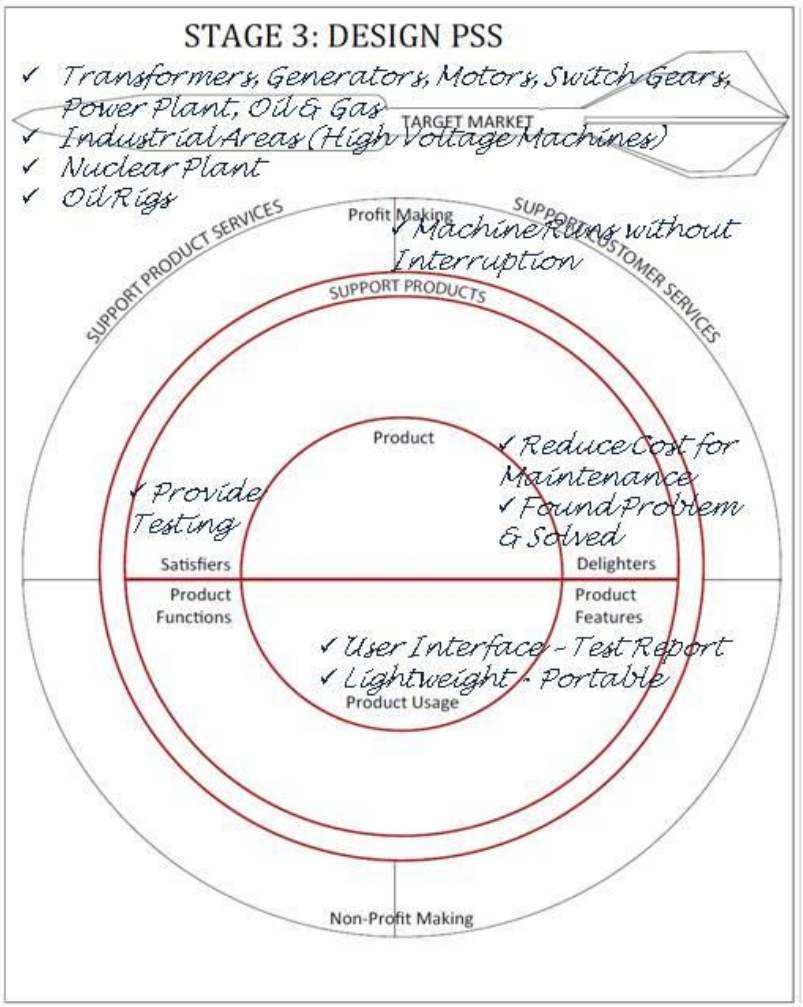
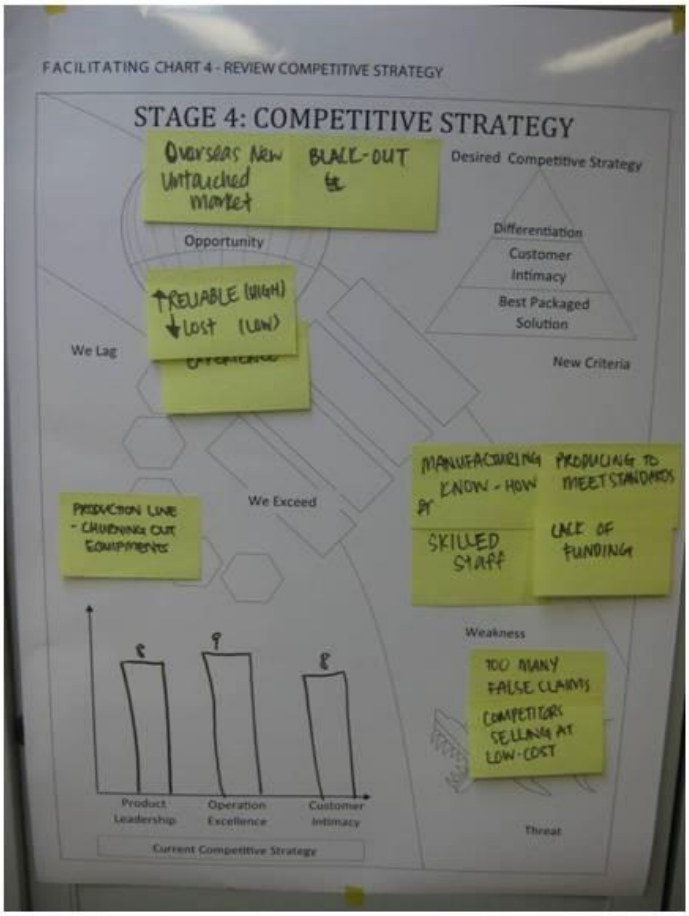
Stage 3: Design PSS

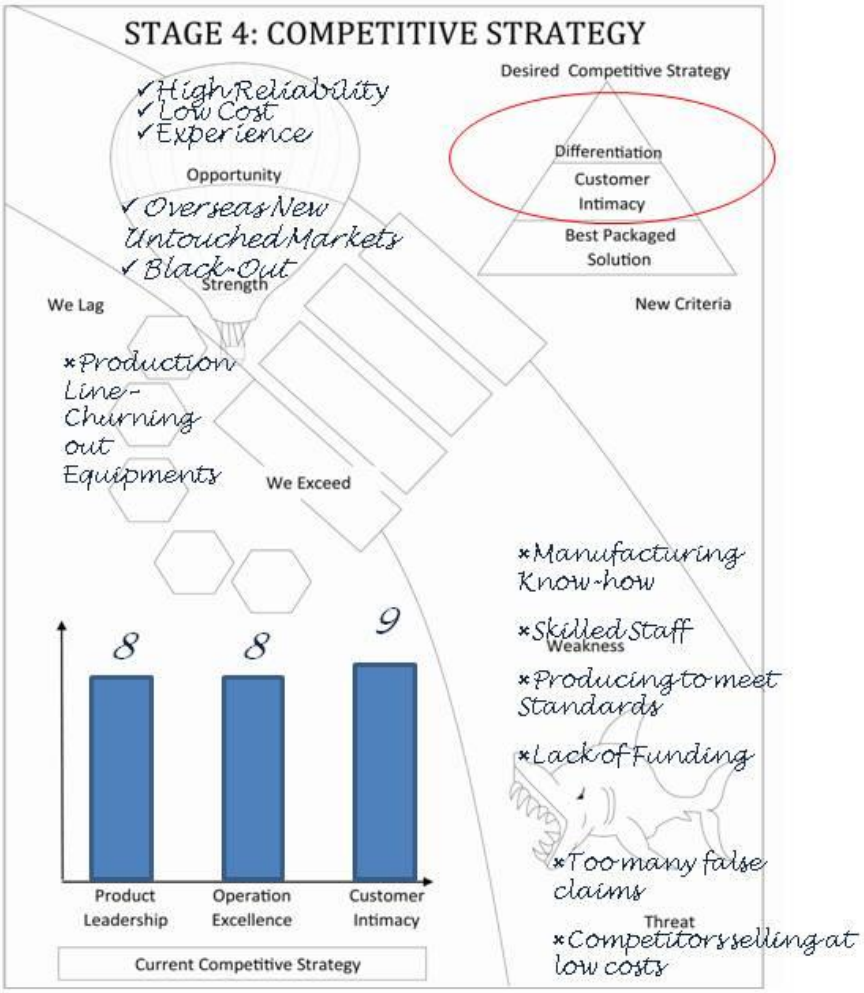
Stage 3: Design PSS



Stage 4: Review Competitive Strategy



Stage 4: Review Competitive Strategy



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Work Sheet 3.1: Design New Activities for PSS

Origin of Product	Singapore
Manufacturing Facilities	Singapore
Manufacturing Activities	Purchasing Assembly Packaging Testing
Quality Control	Drop Test Functional Test
Finished Product	Partial Discharge Analyser
Marketing	Marketing Mailer Exhibition
Sales	Quotation Order Processing
Admin	Service Contract - Result Oriented PSS
Service	Testing per equipment Repair Maintenance Training
Delivery of Services	Service Contract - Result Oriented PSS

New PSS Services

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Work Sheet 3.2: Identify Critical Resources for New PSS

A1- Service Contract – Result Oriented PSS
A2 - Testing per Equipment

	New PSS Activities	Measures					Critical Resources
Resources		Sup	I	D	Sub	A	
Physical							
Financial	A1- need finance staff to draft the new service contract	1	1	1	1	1	5 - NO
Human	A1 – need admin staff to process the contract	1	1	1	1	1	5 - NO
Technological	A2 – need skilful technical people to deliver the testing	4	4	4	3	5	20 - YES
Organisational							
Reputation	A2 – brand reputation is required to carry out the new services	3	3	3	4	4	24- YES

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Work Sheet 4.1: SWOT Analysis

STRENGTH	WEAKNESS
✓High Reliability ✓Low Cost ✓Experience	*Manufacturing Know-how *Skilled Staff *Producing to meet Standards *Lack of Funding
OPPORTUNITY	**THREAT**
✓Overseas New Untouched Markets ✓Black-Out	*Too many false claims *Competitors selling at low costs

Work Sheet 4.2: Review Current Competitive Strategy

Part I

Statement	Agree	Dis-agree	Don't Know
1. Our services provide exactly what our customers need	X		
2. Our core processes are client acquisition and development, and solution development	X		
3. We are intolerant to error, mistakes, and poor quality and provide zero defect service to our customers	X		
4. We win the market through great products and invent, develop, and market – fast		X	
5. Important improvement levers for us are process redesign and continuous improvement	X		
6. Our company is recognised as a provider of best total solution – provide better overall result for the clients than anyone else		X	
7. We target our R & D towards development of devices that are smaller, faster, lighter, cooler, cheaper and whatever constitutes better performance than those existing		X	
8. A customer is not dependent on us we dependent on him, customer satisfaction is the first thing	X		
9. We provide swift delivery and dependable service		X	
10. Our employees jobs are structured around the creation of products, not around any particular function			

Work Sheet 4.2: Review Current Competitive Strategy

Part II

Statement	Agree	Dis-agree	Don't Know
11. We believe in solving customers broader problem – attend to much broader range of client's need	X		
12. We are passionate about measuring and monitoring to ensure rigorous quality and cost control		X	
13. We have compensation systems that reward success and constant product innovation is encouraged		X	
14. We recognise that the company's current success and future prospects lie in its talented product design people and those who support them	X		
15. We often put ourselves at risk to further our client's success		X	
16. We actively collect performance feedback from our customers	X		
17. We provide product reliability, durability, dependability at the lowest total cost		X	
18. We focus on the core processes of invention, product development, and market exploitation		X	
19. We have standardised and efficient operating procedures	X		
20. We have deep customer knowledge and insights about the client's underlying processes	X		

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Work Sheet 4.2: Review Current Competitive Strategy

Part III

Statement	Agree	Dis-agree	Don't Know
21. Being creative is most important for us & we are trend setters and pioneers in the products we create		X	
22. Our company is recognised as a provider of best total cost	X		
23. We try to minimise our distribution and transportation costs		X	
24. We have the responsiveness-willingness to help customers and provide prompt service	X		
25. In our company the team is what counts not the individual	X		
26 Our company is recognised as a provider of leading products & we produce a continuous stream of state-of-art products and services		X	
27. We understand how changes to our service offer will benefit our customers	X		
28. We avoid variety in products and maintain a very narrow product line.	X		
29. We recognise the need to educate and lead the market regarding the use and benefits of new and innovative products		X	
30. We believe in retiring (making obsolete) our own products before our competitors do		X	

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Work Sheet 4.3: Score Card for Competitive Strategy Review

No.	Strategy Indicator	Current Competitive Strategy	Desired Competitive Strategy
1	C	X	
C	C	X	
3	O	X	
4	P	X	
5	O		
6	O	X	
7	P		
8	C		
9	O	X	
10	P		
11	C	X	
12	O		
13	P		
14	P	X	
15	C		
16	C	X	
17	P		
18	P		
19	O	X	
20	C	X	
21	P		
22	O	X	
23	O		
24	C	X	
25	O	X	
26	P		
27	C	X	
28	O	X	
29	P		
30	P		

C -- Customer Intimacy Excellence

P -- Product Leadership

O - Operation

Current Competitive Strategy	No. of Cs	8	No. of Ps	9	No. of Os	9

Work Sheet 5.1: PSS Competitive Elements Measurement Chart (PSS-CMC)

Competitive Elements	Variables	We Lag			We Match	We Exceed			Best Packaged Solution	Customer Intimacy	Differentia-tion
		-3	-2	-1	0	1	2	3			
Cost	PSS Package Price							X	3		
	Service / Product						X		2		
Quality	Conformance to Specification							X	3		
	Reliability							X	3		
Flexibility	Variety of Service							X	3		
	Service Recovery							X	3		
	Product Customisation							X	3		
Delivery	Responsiveness						X		2		
	Level of -Service Customisation						X		2		
	Variety of Services						X		2		
Innovative-ness	Product Feature							X	3		
	Service Feature						X		2		
Customer Acceptance	No. of Returned Customer						X			2	
Customer Satisfaction	Acceptance					X				1	
	Willingness to pay						X			2	
Finance Result	Cash flow						X				2
	Turnover						X				2
	Profit						X				2
	Return of Investment						X				2
Marketing Performance	Market share						X				2
	Market penetration							X			3
	Brand Reputation							X			3
									32	5	16

Total score: 53

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Low PSS Competitiveness — High PSS Competitiveness

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Work Sheet 6.1: PSS Servitizability Measurement Chart (PSS-SMC)

Part I

Manufacturing Policy Areas	Assessment Questions	No			Don't know N.A	Yes		
		-3	-2	-1	0	1	2	3
Process and Technology	Does your production able to support the promised service of the new PSS?							X
	Do you have the right process and technology to produce customised service as required by the new PSS?							X
	Does your R&D department capable in design product with features to support the new PSS?					X		
Capacity (of product and service production)	Is the capacity of your production flexible enough to support "different touch point" and flexible demands from the customer in term of special feature of product and service?							X
Facilities - factory size, location etc.	Do you have a service department?							X
	Are you able to replace faulty unit within acceptable time required by customer?	X						
	Is your factory repair unit physical close to the customer's site?				X			
Supply Chain Positioning	Do you have a close integrated supply chain system to deliver fast and responsive service?				X			
	Is your supplier able to support you in the new PSS operation, i.e. product take back or part replacement?				X			
Planning and Control	Are you able guarantee product and service availability to your customer?						X	
	Is your company recognised as a provider of best total solution?							

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Low Servitizability ← → High Servitizability

Case Study's Report Partial Discharge Analyzer Co.

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Work Sheet 6.1: PSS Servitizability Measurement Chart (PSS-SMC)

Part II

Manufacturing Policy Areas	Assessment Questions	No			Don't know / N.A	Yes		
		-3	-2	-1	0	1	2	3
Span of process	Is your process service-oriented?						X	
	Do you have standardized and efficient process to deliver PSS?							
Human Resource	Do you have staff that can interact with customers and provide good service to them?						X	
	Do you have the right skilful service staff to deliver the promised service?							X
Quality Control	Can you deliver the services that meet customer's specification?							X
	Can you product deliver the promised service and functionality?							X
Product/ Service Range	Do you have the suitable product to support the new PSS?							X
	Are you able to provide services exactly what the customer wanted?							X
	Do you have the responsiveness to provide prompt service?					X		
	Are you able to solve client's problems and attend to much broader range of customer's need?						X	
	Do you have deep customer knowledge and insights about your customer's underlying process?					X		
New PSS Introduction	Do you have a finance/billing system support the new PSS operation?						X	
	Does your product possess features to monitor the real time usage and health check of the new PSS operation?				X			
	Are the new services you intend to provide inimitable?				X			

TOTAL SCORE 53

Case Study's Report Partial Discharge Analyzer Co.

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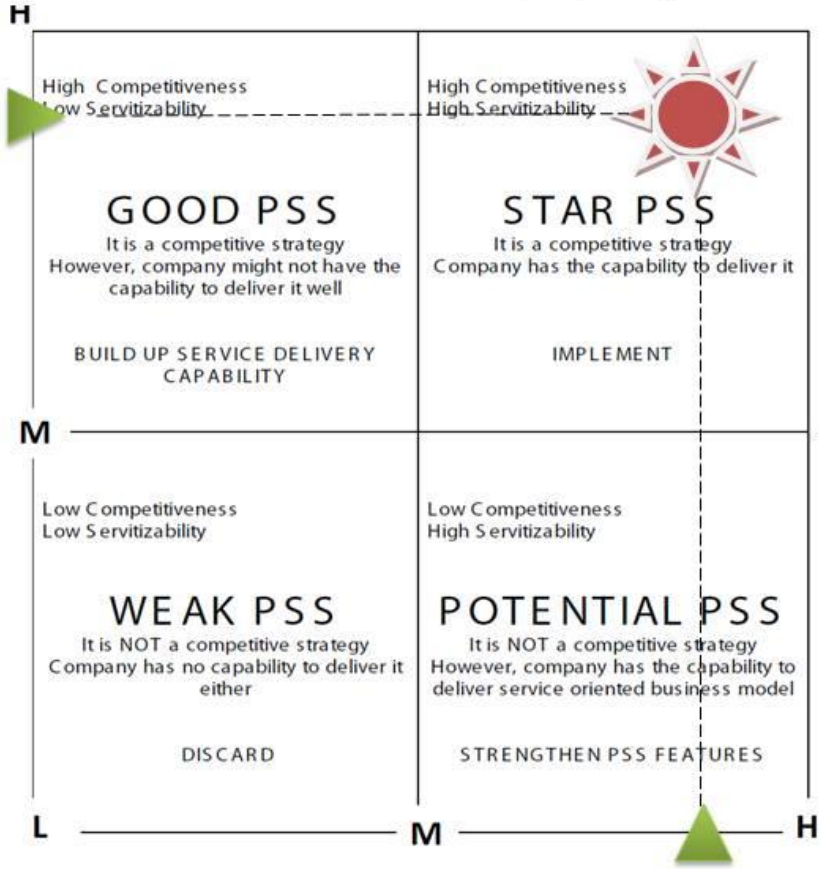
PSS STRATEGY COMPETITIVENESS ASSESSMENT RESULT:

Level of PSS Competitiveness: High
Level of Servitizability of Company: High



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Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	Result Oriented PSS – Equipment Health Inspection Service Selling the testing of partial discharge per equipment
LEVEL OF PSS COMPETITIVENSS	L M **H**
LEVEL OF SERVITIZABILITY	L M **H**
IS PSS A GOOD COMPETITIVE STRATEGY?	**YES** NO
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** STAR PSS WEAK PSS POTENTIAL PSS
CRTICAL RESOURCES REQUIRED TO IMPLEMENT NEW PSS STRATEGY	✓ Brand reputation ✓ Skilful technical staff
FUTURE ACTION	✓ Will implement the proposed Result oriented PSS in selling "partial discharge testing per equipment" as discussed in this workshop ✓ Will hire new service engineer to support the operation ✓ Would like to implement new PSS strategy for another product

CASE STUDY S2 | Beauty Machine Co.

Case Study's Report Beauty Machine Co.

S2

Introduction

Beauty Machine Co. designs and manufactures its own range of hair care products such as hair dryers and hair irons, machines such as mist and steaming machines as well as accessories such as hair clips etc. for salons and end consumers. The company has manufacturing plants in Malaysia and China. In addition to manufacturing and selling hair care products it also provide sourcing services to foreign companies outside Singapore to buy or sell hair care products in and out of China.

Participants:
Mr Toh – Managing Director
Product Engineer
Marketing Engineer

Stage 1: Scope Issues

The core competency of the company has been identified as established distribution channels which are something that cannot be copied by competitors within a short period of time. Reason identified for moving towards Servitization is that the beauty machines developed by the company are very complex and sophisticated, as a result, it is hardly can be easily afford by the customers. Current overriding problems are that they are facing stiff competition from their competitors, and the customer's expectation is beyond normal acceptable level. The product identified for Servitization is the beauty machine that has been designed and developed by the company. The intention is to sell it as a result oriented PSS, that is, to provide the beauty treatment services to the salon by using the machine. The Servitization task force team was formed by the following people:

- 1. Mr Toh – Managing Director, Taskforce Leader
- 2. Product Engineer
- 3. Marketing Engineer

Core Competency
Established Distribution Channels
Manufacturing Facility in China

Reasons for Moving towards Servitization
Expensive Sophisticated Machines

Overriding Challenges / Problems
Stiff Competition
High Client Expectations – Beyond Norm

Identify Products for Servitization Review
Beauty Machines

Case Study's Report Beauty Machine Co.

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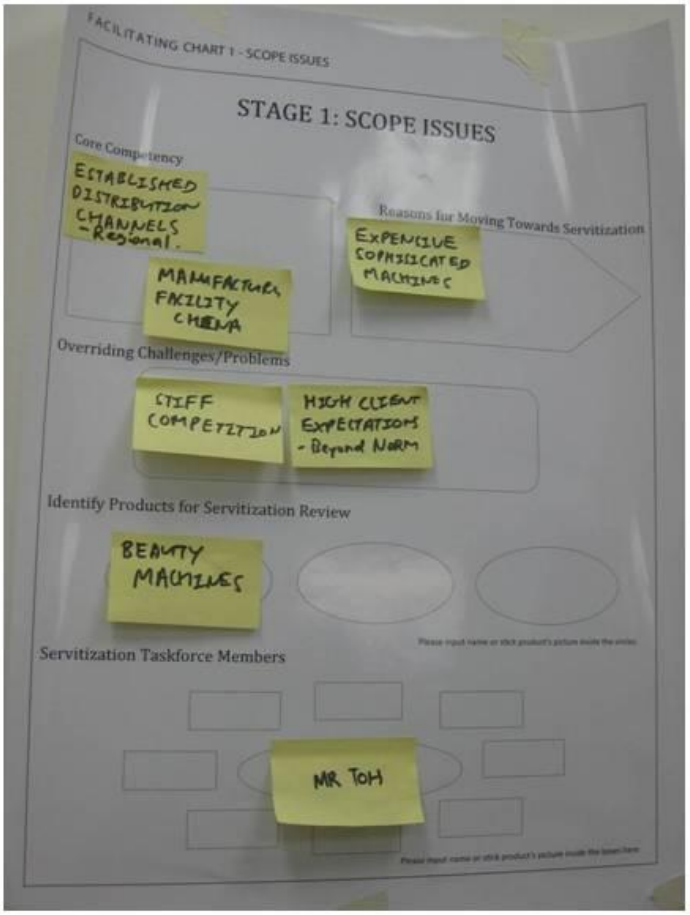
Stage 1: Scope Issues



Stage 2: Identify Servitization Landscape

Stage 2 of the PSSE methodology focuses in understanding the customer needs and identifies drivers and barriers towards Servitization. Customer needs have been identified as joint advertising program to bring in customers, guaranteed machine uptime and training. The drivers identified for moving towards Servitization are high profit margin and high capital outlay. Barriers identified are aesthetics of machines, lack of people to execute the ideas and staff are resistant to change. The PSS strategy proposed is a result oriented PSS which offer customer the value in use of treatment package solutions.

Drivers
High Profit Margin
High Capital Outlay

Service / Customer's Needs
Joint Advertising Program to bring in customers
Guaranteed Machine Uptime
Provide Training

Barriers
Aesthetics of Machines
Lack People to execute the ideas
Resistant to change

Result-Oriented PSS
Treatment Package Solutions

Case Study's Report Beauty Machine Co.

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Case Study's Report Beauty Machine Co.

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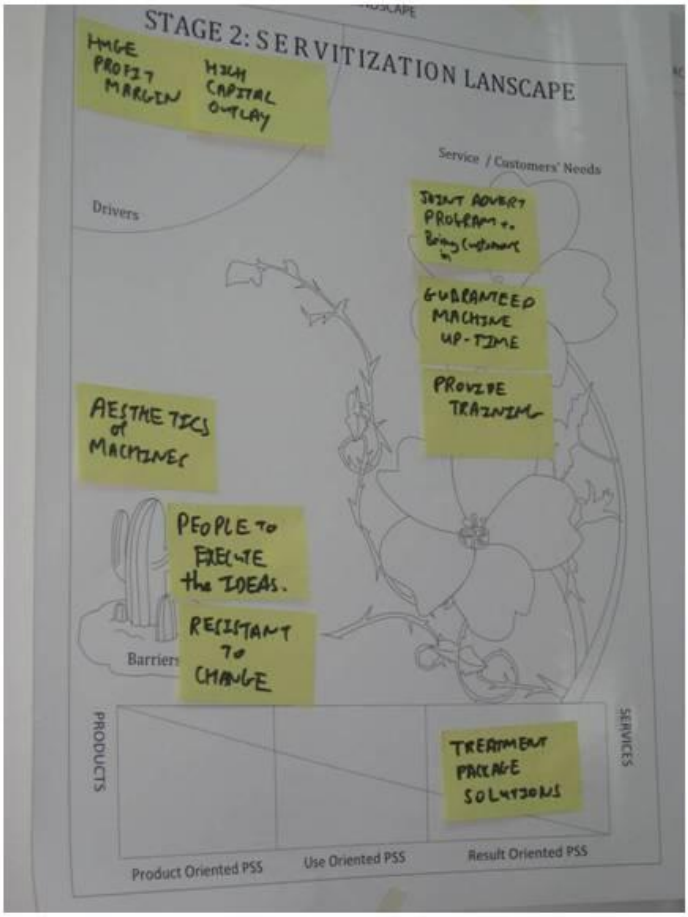
Stage 2: Identify Servitization Landscape



Stage 3: Design PSS

Stage 3 of the PSSE methodology involves understanding customer's needs. Customer's needs can be divided into satisfiers and delighters. Satisfiers identified in this stage are good treatment results produced by the beauty machines. Delighters identified as additional functions the machines can offers, for example, special red or blue light to close pore or improve blood circulation, stimulate hair grow and fight hair loss. Product features required in delivering the customers' satisfiers and delighters are beauty machines with led light and x ray functions. The team has identified that the services that supporting customers such as training and product sales for the machine are profitable.

Case Study's Report Beauty Machine Co.

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Stage 4: Review Competitive Strategy

Stage 4 of the PSSE methodology first performs the SWOT analysis. Strengths identified are economy of scale and leading global brands; Opportunities identified are regional and global market, growing China domestic market; Weaknesses identified are lack of manpower and consumers ignorance – tend to go for fads rather than quality of the machines; and Threats are that Asian customers preferred to chose for Japan & Korean's brand as well as globalisation of Chinese companies. The company exceeding their competitors in terms of addressing customers technical needs, whereas lagging behind them in terms of image and brand as compared to some of the international brands due to the lack of strong financial resources. Current competitive strategy assessed to be product leadership.

Strengths
Economy of Scale
Able to communicate effectively with leading global brands

Opportunities
Regional / Global Markets
Growing China Domestic Market

Weaknesses
Lack of Manpower
Consumers Ignorance – Tend to go for Fads

Threats
Asian Customers tend to go for Japan & Korean Brand
Globalisation of Chinese Companies

We Exceed
Address Customers Technical Needs

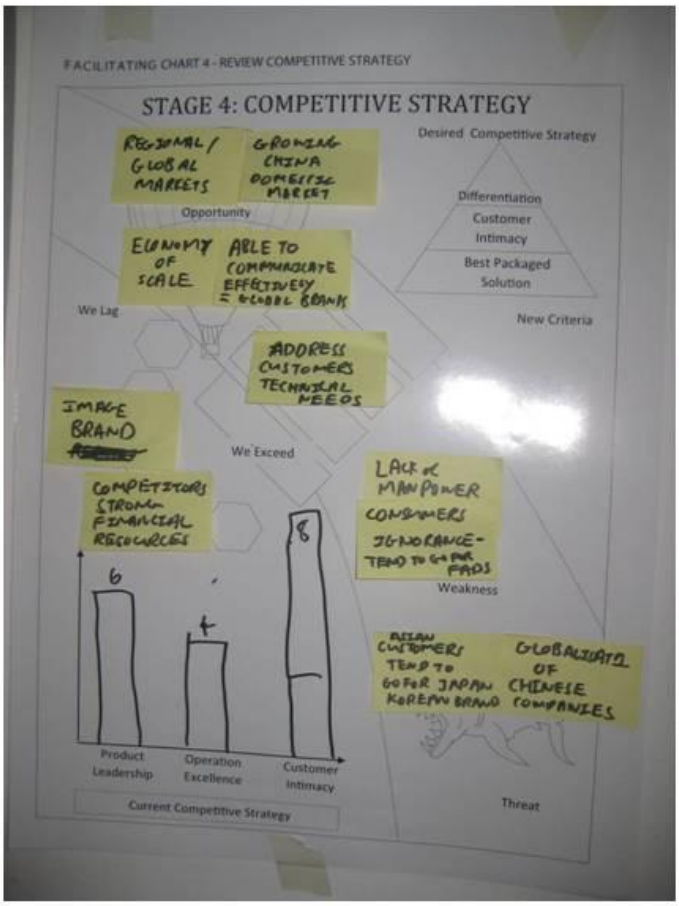
We Lag
Image / Brand
Competitors Strong Financial Resources

Case Study's Report Beauty Machine Co.

S1

8

Stage 4: Review Competitive Strategy



Case Study's Report Beauty Machine Co.

S1

9

Stage 5: Assess PSS Competitive Elements

Stage 5 assesses the competiveness of the three competitive dimensions of the new PSS strategy, namely, best packaged solution, customer intimacy and differentiation. In the category of Best Packages Solutions, elements such as Cost and Flexibility are lagging behind competitors whereas elements such as Quality, Delivery and Innovativeness are exceeding the competitors. In the aspect of customer intimacy, Customer Acceptance is exceeding its competitors and Customer Satisfaction matches the competitor. The company is doing well in terms of Finance and Market Performance. The competitiveness of the PSS elements has been assessed to High with an average score of 36

PSS Competitive Elements Score <=0 (we lag):
Flexibility

PSS Competitive Elements Score >=0 (we exceed):
Quality, Innovativeness, Cost, Delivery, Customer Satisfaction, Customer Acceptance, Finance Performance, Marketing Performance

Overall PSS Competitiveness Score:
Best Packaged Solutions: [redacted] 17
Customer Intimacy: [redacted] 6
Differentiation: [redacted] 13

Best Packaged Solution	17	19%
Customer Intimacy	6	67%
Differentiation	13	62%
Overall Score	36	54%
PSS Competitiveness	High	

Case Study's Report Beauty Machine Co.

S1

10

Stage 6: Assess Servitizability of Company

Stage 6 of the PSSE methodology performs the Servitizability of the company in term of its structure and infra-structure policy areas. The company scored high in manufacturing areas such as Process and Technology and Facilities. It needs improvement in areas such as Planning and Control and Capacity. The overall Servitizability of the company has been assessed to be in the High with an average score of 37.

Manufacturing Policy Areas <=0 (not ready):
Planning and Control

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Facilities, Span of Process, Human Resource, Quality Control, Capacity Product/Service Range, New PSS Introduction

Overall Servitizability Score:
Structure [redacted] 16
Infrastructure: [redacted] 30

Structure	16	44%
Infrastructure	30	80%
Overall Score	46	62%
Servitizability	High	

The PSSE Methodology 2010

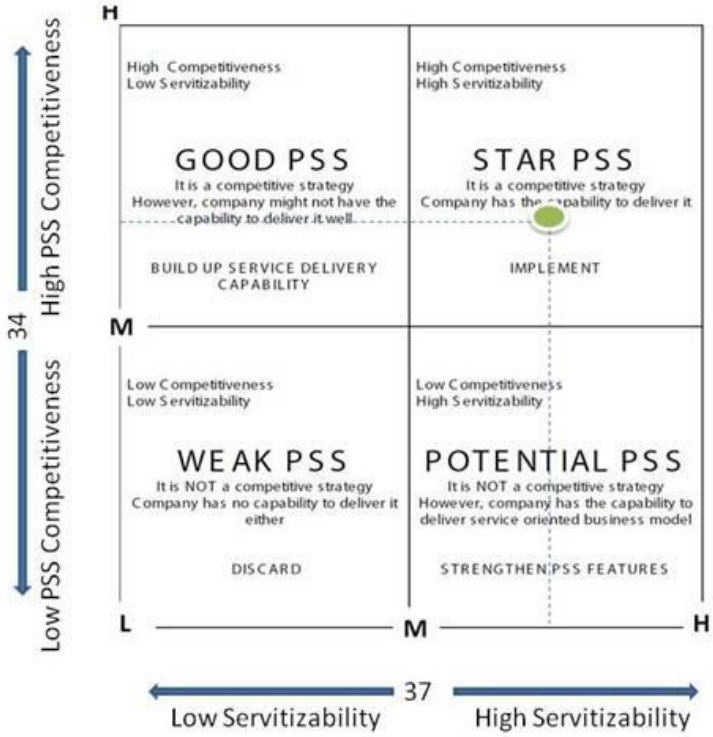
Case Study's Report Beauty Machine Co.

S1

11

Stage 7: Determine Type of PSS Strategy

The last stage of the PSSE methodology consolidates the outcomes and generates the final PSS competitiveness score card by using the PSS Competitiveness Assessment Matrix (PSS-CAM). The final results produced for Beauty Machine Co. are as follows:



The proposed new PSS is identified as a STAR PSS competitive strategy. The company generally posses the right capability to deliver the new PSS strategy. The PSS strategy proposed also consists of moderately strong competitive elements in all the three PSS competitive dimensions.

Case Study's Report Beauty Machine Co.

S1

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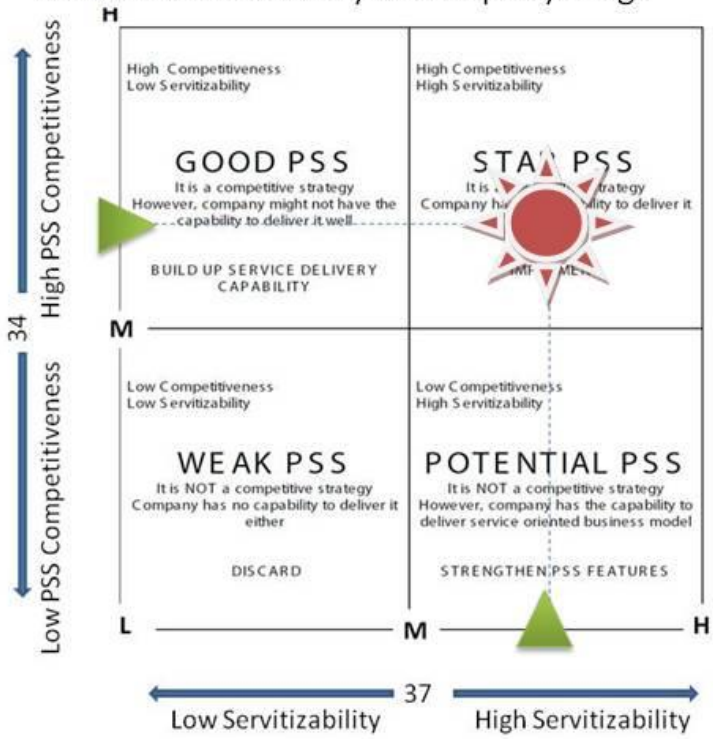
PSS STRATEGY COMPETITIVENESS ASSESSMENT RESULT:

Level of PSS Competitiveness: Low
Level of Servitizability of Company: High



The PSSe Methodology 2010

Case Study's Report Beauty Machine Co.

S1

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Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	*Result Oriented PSS in selling beauty treatment solution by using beauty machines*
LEVEL OF PSS COMPETITIVENSS	L **H**
LEVEL OF SERVITIZABILITY	L **H**
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** **STAR PSS** **WEAK PSS** **POTENTIAL PSS**
CRTICAL RESOURCES REQUIRED TO IMPLEMENT NEW PSS STRATEGY	
FUTURE ACTION	✓ *To improve on area that is currently not competitive enough, especially in the area of Flexibility and Planning and Control. The company needs to re-develop special product features for the machine to monitor actual usage.*

CASE STUDY S3 | Hydro and Thermal Co.

Case Study's Report Hydro and Thermal co.

S3

Introduction

Hydro and Thermal Co. is a new start-up company focuses in manufacturing and distribution of ionic water heaters. The founder of this company is an ex-staff of Case P1. The company intends to manufacture and distribute ionic instant water heater and a range of consumer electronic white goods targeted at the South East Asia market. The company also have intention to distribute medical devices in the future. The PSS discussed during the PSSE workshop is a simple Product Oriented PSS with a list of services designed to support the sales of the new ionic instant water heater.

Participants:
Mr Dalton – Managing Director
Ms Lili – Marketing manager

The PSSe Methodology 2010

Case Study's Report Hydro and Thermal co.

S3

2

Stage 1: Scope Issues

The core competency of the company has been identified as manufacturing know-how of water heater and innovativeness. The reasons identified for moving towards Servitization are differentiation and to create new market segment. Current overriding problems are lack of technical resources and lack of existing distribution channels. The product identified for Servitization is instant Ioniser heater. The Servitization task force team was formed by the following people:

- Mr Dalton – Managing Director, Taskforce Leader
- Mr Lili – Marketing manager

Core Competency
Innovative Design
Low Overhead Costs

Reasons for Moving towards Servitization
Differentiation
Create new market segment

Overriding Challenges / Problems
Lack of technical resources
Lack of existing distribution channels

Identify Products for Servitization Review
Ionizer Heater

Ionizer Heater

Case Study's Report Hydro and Thermal co.

S3

3

Stage 2: Identify Servitization Landscape

Stage 2 of the PSSE methodology focuses in understanding the customer needs and identifies drivers and barriers towards Servitization. Customer needs have been identified as customers are more becoming more particular with showering as well as to leverage on the lifestyle of countries with poor environment. The drivers identified for moving towards Servitization are first, the intention of wanted to combine a complimentary function into water heater; second, to create a preferred product selections and preferred brand, third, consumers are becoming more health-conscious; forth, to create extra-functionality and value-add; and fifth, current lifecycle trend of moving towards environment friendly. Barriers identified are, safety conformance to testing procedure, change in products reliability or life-cycle, product acceptance, no history / track record of functionality, design feasibility, manufacturability and no IP protection from low cost country competitors.

Drivers
Wanted to combine a complimentary function into water heater
To create a preferred product selections / preferred brand
Health-conscious society
Extra-functionality (value-added)
Current trend (promo on environment friendly)

Service / Customer's Needs
Customers are more particular with showering
Leverage the lifestyle of country with poor environment
Convenience showering
Healthier lifestyle
Luxurious lifestyle
Customers want to be different
Mindset of refreshing / rejuvenating
To pamper oneself
As status symbol / lifestyle product

Stage 2: Identify Servitization Landscape

Barriers

Safety conformance to testing procedure
Change in products reliability or life-cycle
Product acceptance
No history / track record of functionality
Design feasibility
Manufacturability
IP protection from low cost country competitors

Non-Profit		Profit-Making	
Warranty FOC 2 Yrs	Outsource	Outsource	Trade-In & Upgrade
Onsite Repair	Outsource	Outsource	Extended Warranty
Customer Training	Inhouse Marketing	Outsource	Installation
Product Education	Publicity Advertisements Article Work with health physicians		Replacement Market
Material Marketing Support	Marketing		

Stage 3: Design PSS

Stage 3 of the PSSE methodology involves understanding customer's needs. Customer's needs can be divided into satisfiers and delighters. Satisfiers identified in this stage are accuracy, speed & reliability and Inspection Results Report. Delighters identified as the automated defects recovery and user friendly interface. Product features required in delivering the customers' satisfiers and delighters are vision scopes and usage tracking system. The team has identified that the services that supporting customers such as training and inspection are profitable.

Customer Satisfaction
Hot water & ionized environment
Clean hot water

Customer Needs
Satisfiers
Reliability performance
Hot water
Easy functionality
Easy Interface
Safety Requirement – PSB Marking
Desired water temperature

Delighters
Ionizing environment convenience 2-in-1 device
Modern design
Auto-safety function (auto shut-down)

Product Features
Heating level control – Thermostat
Anti-rust
Indication (Heating temperature, ionization level, flow control)

Case Study's Report Hydro and Thermal co.

S3

5

Case Study's Report Hydro and Thermal co.

S3

6

Stage 4: Review Competitive Strategy

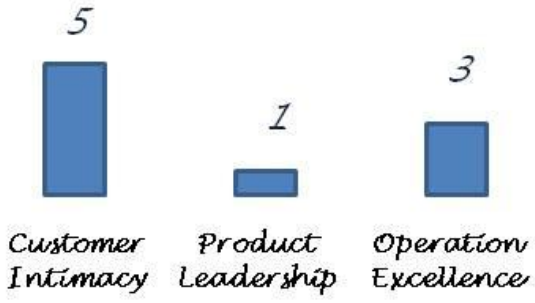
Stage 4 of the PSSE methodology first performs the SWOT analysis. Strength identified is the capability of able to provide inspection down to micro level; Opportunities is that the market is still growing; Weakness are price too expensive and slower inspection speed and Threats are that competitors can build the machine in a shorter time and the entry level to this industry is low. The company exceeds their competitors in terms of reliability and accuracy, however lagging behind in terms of longer turnaround time and slower customer support response time due to lack of local support. Current competitive strategy assessed to be customer intimacy, with the following scores:

Strengths
New management (new concept, flexibility)
Comprehensive network of working partners

Opportunity
Instant water heater has gained popularity in US – New big market
Low barrier of entry
Health-conscious society
3rd World Country Market are still plenty to develop

Weakness
Not enough product range

Threats
Product development too long cycle (> 6 Months)
No economics of scale – profitability
Harsh competition from existing big players
Lack of internal technical specialist
Run out of financial resources
Customers change preferences



Stage 5: Assess PSS Competitive Elements

Stage 5 of the PSSE methodology is one of the most important stages of the entire methodology. It assesses the competiveness of the three competitive dimensions; best packaged solution, customer intimacy and differentiation of the proposed PSS strategy. The company performs well in the category of Best Packages Solutions; elements such as Cost, Delivery, Quality, Flexibility and Innovativeness are all exceeding the competitors. In the aspect of customer intimacy and differentiation, this company scored negative in both categories due to the fact that this is a new stat up company, although they have the best PSS package, they still need to take time to build up its own customer base and market share. The competitiveness of the PSS elements has been assessed to be low with an average score of 13.

PSS Competitive Elements Score <=0 (we lag):
Customer Acceptance, Market Performance

PSS Competitive Elements Score >=0 (we exceed):
Cost, Quality, Flexibility, Delivery, Innovativeness, Customer Satisfaction, Finance Performance,

Overall PSS Competitiveness Score:
Best Packaged Solutions: [redacted] 19
Customer Intimacy: ✕ -1
Differentiation: ✕✕✕ -5

Best Packaged Solution	19	53%
Customer Intimacy	-1	-11%
Differentiation	-5	-24%
Overall Score	13	20%
PSS Competitiveness	LOW	

Case Study's Report Hydro and Thermal co.

S3

8

Stage 6: Assess Servitizability of Company

Stage 6 of the PSSE methodology performs the Servitizability of the company in term of its structure and infra-structure policy areas. The company scored high in manufacturing areas such as Process and Technology, Span of Process, Human Resource and Product Service Range. However, it needs improvement in areas such as Supply Chain Positioning, Facilities and Planning and Control which have scored negative marks during the assessment. The overall Servitizability of the company has been assessed to be High with an average score of 44.

Manufacturing Policy Areas <=0 (not ready):
Supply Chain Positioning, Planning and Control, Capacity

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Facilities, Span of Process, Human Resource, Quality Control, Product/Service Range, New PSS Introduction

Overall Servitizability Score:
Structure [redacted] 11
Infrastructure: [redacted] 32

Structure	12	31%
Infrastructure	32	89%
OverallScore	44	60%
Servitizability	High	

The PSSe Methodology 2010

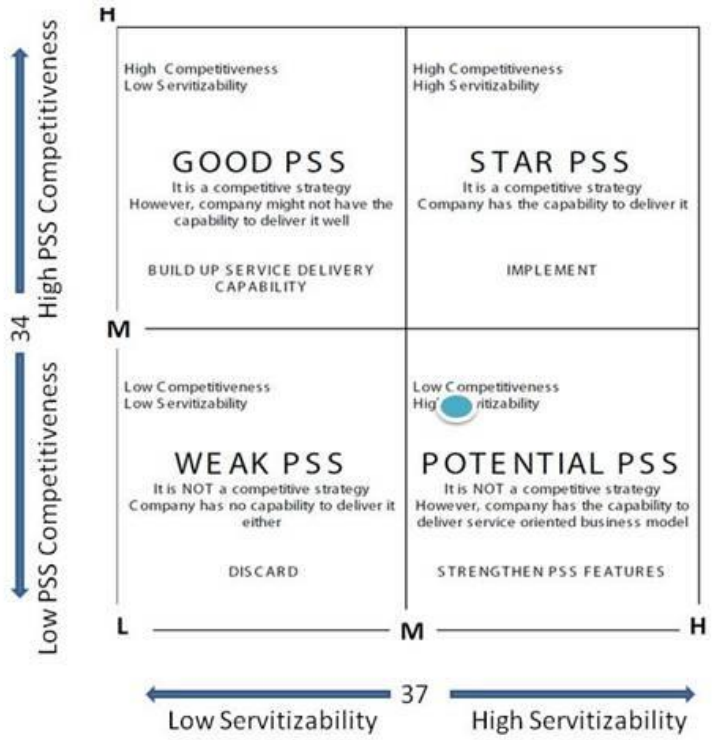
Case Study's Report Hydro and Thermal co.

S3

9

Stage 7: Determine Type of PSS Strategy

The last stage of the PSSE methodology consolidates the outcomes and generates the final PSS competitiveness score card by using the PSS Competitiveness Assessment Matrix (PSS-CAM). The final results produced are as follows:



The proposed PSS is identified as a POTENTIAL PSS. As Hydro and Thermal Co. is a rather young company, it generally possesses the flexibility, structure and mind set to deliver the new PSS strategy. However, the competitive elements of the new PSS not generally not strong enough and thus need improvement especially in the areas of Customer Acceptance and Marker Performance.

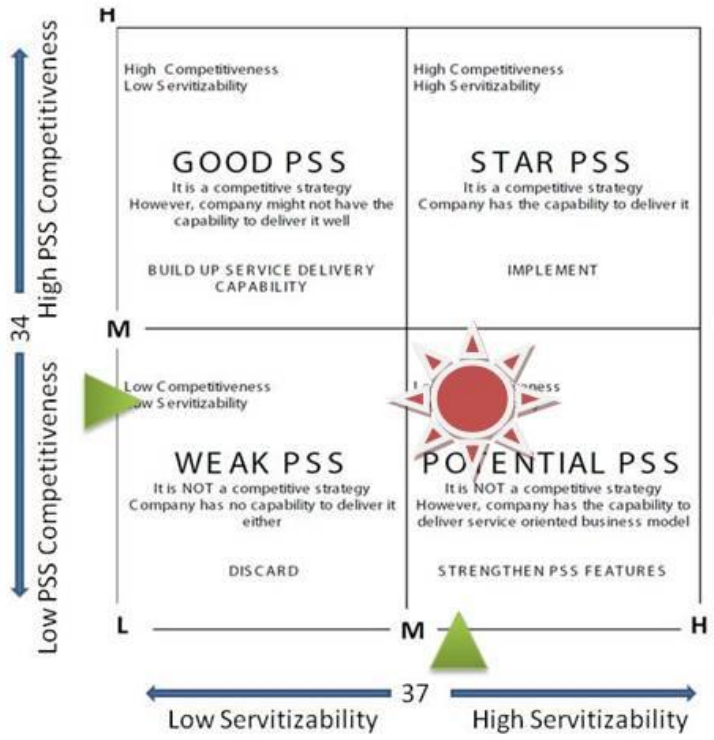
Case Study's Report Hydro and Thermal co.

S3

10

PSS STRATEGY COMPETITIVENESS ASSESSMENT RESULT:

Level of PSS Competitiveness: Low
Level of Servitizability of Company: High



Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	*Product/Use Oriented PSS in delivering the value in use of hot water with ions by using Ionic Instant Water Heater*
LEVEL OF PSS COMPETITIVENSS	**L** **H**
LEVEL OF SERVITIZABILITY	**L** **H**
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** **STAR PSS** **WEAK PSS** **POTENTIAL PSS**
FUTURE ACTION	✓ *To improve on all the PSS elements that currently not competitive enough, especially in the area of Customer Acceptance and Market Share which have scored negatively*

Case Study's Report Hydro and Thermal co.

S3

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CASE STUDY S4 | Semi-con Equipment Co.

Case Study's Report Semi-Con Equipment Co.

S4

Introduction

Semi-con Equipment Co. provides printed circuit board, assembly, manufacturing and equipment design services. It currently provides value-added services such as circuit layout, materials management, prototype and development engineering in the industrial equipment market. The company has built its own brand of semi-conductor equipment in water inspection and manufacture machines that are built to customer specification. The company business concept has been moving from product oriented PSS, to use oriented PSS and is currently exploring developing products to cater for result oriented PSS.

Participants:
Mr Tan Ka Huat – Taskforce Leader
Mr Peh Meng Hing – Product Expert
Mr Kayson – Manufacturing Expert
Mr Jan Choo Jiaming – Service Expert

Case Study's Report Semi-Con Equipment Co.

S4

2

Stage 1: Scope Issues

The core competency of the company has been identified as micron-Level Inspection for inspecting the default of wire bond of wafer. The company develops one of the best 3rd optical inspection machines in the market. However, due due to high selling price, the sale of the machine is low. Selling 3rd optical inspection machine as a PSS has been identified as one of the most important reasons for moving towards Servitization. The intention is to sell it as a result oriented PSS, that is, to provide the wafer wire bond inspection service for their clients so as to encourage more companies to use their inspection equipment.

During stage 1, the current overriding problems identified are that their competitors can generally offering much cheaper products with good quality, and the customers are expecting faster lead time in the production of the new equipment.

The Servitization task force team was formed by the following people:

- Mr Tan Ka Huat – Managing Director, Taskforce Leader
- Mr Peh Meng Hing – Product Expert
- Mr Kayson – Manufacturing Expert
- Mr Jan Choo Jiaming – Service Expert

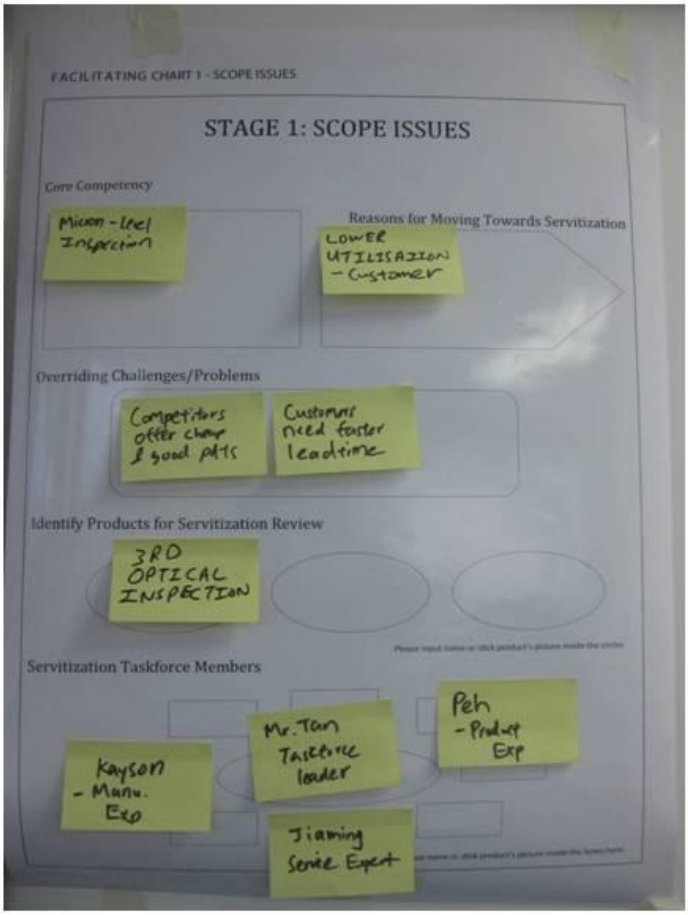
3rd optical inspection machine

Case Study's Report Semi-Con Equipment Co.

S4

3

Stage 1: Scope Issues



Case Study's Report Semi-Con Equipment Co.

S4

4

Stage 2: Identify Servitization Landscape

Stage 2 of the PSSE methodology focuses in understanding the customer needs and identifies drivers and barriers towards Servitization. Customer needs have been identified as Quality and Reliability of the inspection service and Pricing. The drivers identified for moving towards Servitization are IE Singapore and Spring Support (these are two of the government organisations in Singapore whose mission is to help the local industry to grow and venture overseas), to increase market share and the opportunities of developing new automated inspection machine with new feature for PSS. Barriers identified are strong competitors, fierce cost competition and customers expecting 100% service support.

Drivers
IE Singapore / Spring Support
Increase market share
Technology – Automated with vision inspections

Service / Customer's Needs
Quality of Wire bond
Reliable
Pricing

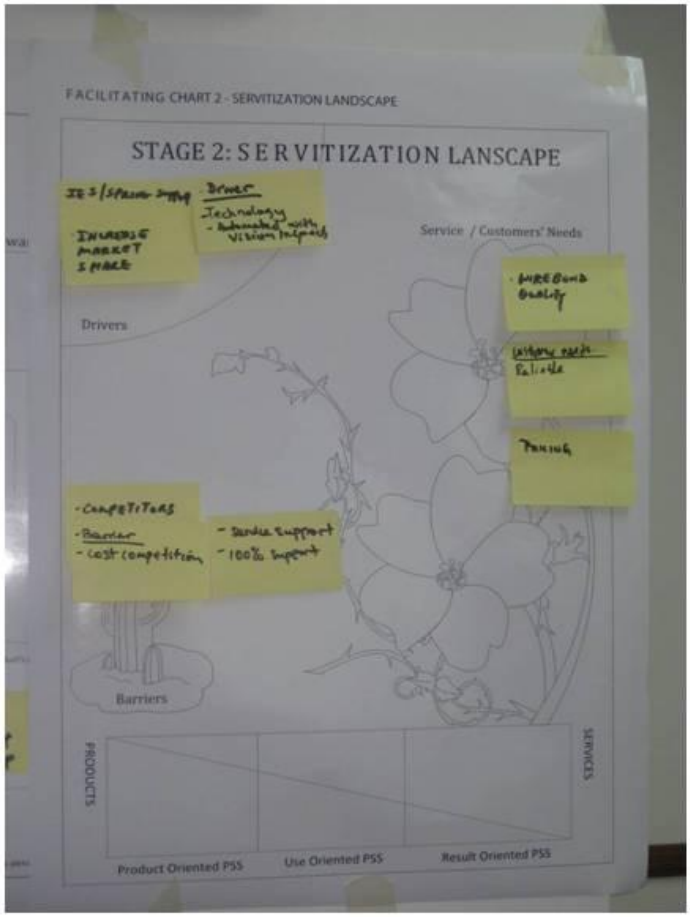
Barriers
Competitors
Cost Competition
Service Support
100% Support

Case Study's Report Semi-Con Equipment Co.

S4

5

Stage 2: Identify Servitization Landscape



Stage 3: Design PSS

Stage 3 of the PSSE methodology involves understanding customer's needs. The satisfiers identified in this stage are accuracy, speed, reliability and inspection results report. Delighters identified are automated defects recovery and user friendly interface. Product features required in delivering the customers' satisfiers and delighters are vision scopes and usage tracking system. The team has identified that the services that supporting customers such as training and inspection are profitable.

Target Market
Semicon IC Assembly & Test

Customer Needs
Satisfiers
Accuracy, Speed & Reliability
Inspection Results Report

Delighters
Automated Defects Recovery
User Friendly

Product Usage
Automated Visual Inspection

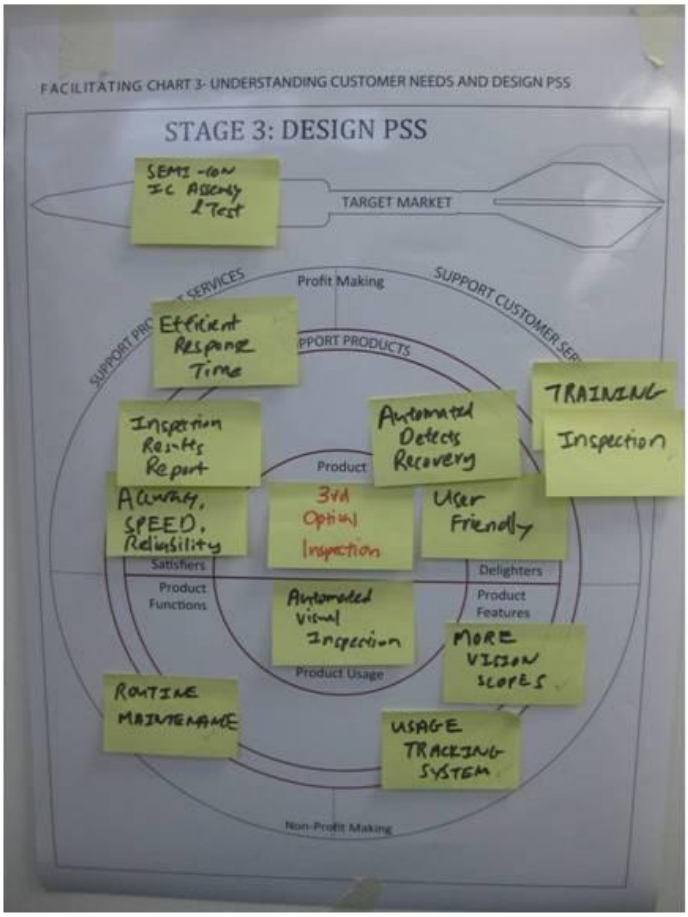
Product Features
More Vision Scopes
Usage Tracking System

Support Product Services – Profit Making
Efficient Response Time

Support Product Services – Non-Profit Making
Routine Maintenance

Support Customer Services – Profit Making
Training
Inspections

Stage 3: Design PSS



Case Study's Report Semi-Con Equipment Co.

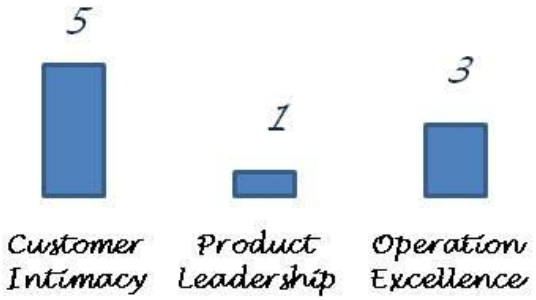
S4

8

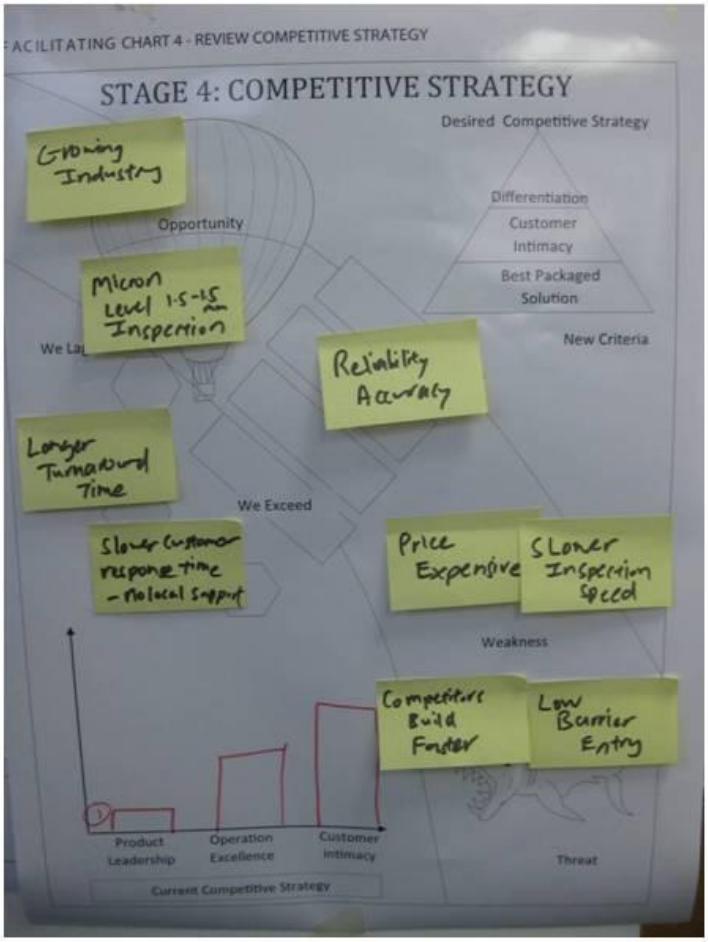
Stage 4: Review Competitive Strategy

Stage 4 of the PSSE methodology first performs the SWOT analysis. Capability of able to provide inspection down to micro level has been identified as the Strength of the company. One of the Opportunities identified is that the market is still growing; Weaknesses of the new PSS are price too expensive and slower inspection speed. Threats identified are first, the competitors are able to build the machine in a much shorter time and second, the entry level to this industry is low. The company exceeds their competitors in terms of reliability and accuracy, whereas lagging behind in terms of longer turnaround time and slower customer support response time due to lack of local support. The current competitive strategy assessed to be customer intimacy. The score is shown in the Table below:

Strengths
Micron Level Inspection 1.5 – 1.5 mm
Opportunity
Growing Industry
Weakness
Price Expensive
Slower Inspection Speed
Threats
Competitors Build Faster
Low Barrier Entry
We Exceed
Reliability
Accuracy
We Lag
Longer Turnaround Time
Slower Customer Response Time – No Local Support



Stage 4: Review Competitive Strategy



Case Study's Report Semi-Con Equipment Co.

S4

10

Stage 5: Assess PSS Competitive Elements

Stage 5 of the PSSE methodology assesses the competiveness of the three competitive dimensions namely, best packaged solution, customer intimacy and differentiation of the proposed PSS strategy. In the category of Best Packages Solutions, participants identified Cost, Delivery and Flexibility as elements lagging behind competitors whereas Quality and Innovativeness are elements exceeding their competitors. In the aspect of customer intimacy, Customer's willing to pay has been identified as factor lagging behind their competitors. In the aspect of differentiation, the company believes that they are able to do well in areas like Market Share, Market Penetration and Brand Reputation. The competitiveness of the PSS elements has been assessed to be Low with an average score of only 13.

PSS Competitive Elements Score <=0 (we lag):
Cost, Flexibility, Delivery, Customer Satisfaction

PSS Competitive Elements Score >=0 (we exceed):
Quality, Innovativeness, Customer Acceptance, Finance Performance, Marketing Performance

Overall PSS Competitiveness Score:
Best Packaged Solutions: [redacted] 5
Customer Intimacy: [redacted] 3
Differentiation: [redacted] 5

Best Packaged Solution	5	14%
Customer Intimacy	3	33%
Differentiation	5	24%
Overall Score	13	20%
PSS Competitiveness	Low	

The PSSe Methodology 2010

Stage 6: Assess Servitizability of Company

Stage 6 of the PSSE methodology assess the level of Servitizability of the company in term of its structure and infra-structure policy areas. The company scored well in manufacturing areas such as Product/Service Range and New PSS Introduction. It needs improvement in areas such as Supply Chain Control and Planning and Control which as both of them scored a negative during the assessment. The overall Servitizability of the company has been assessed as High with an average score of 43.

Manufacturing Policy Areas <=0 (not ready):
Supply Chain Positioning, Planning and Control, Capacity

Manufacturing Policy Areas >=0 (ready):
Process and Technology, Facilities, Span of Process, Human Resource, Quality Control, Product/Service Range, New PSS Introduction

Overall Servitizability Score:
Structure [redacted] 11
Infrastructure: [redacted] 32

Case Study's Report Semi-Con Equipment Co.

S4

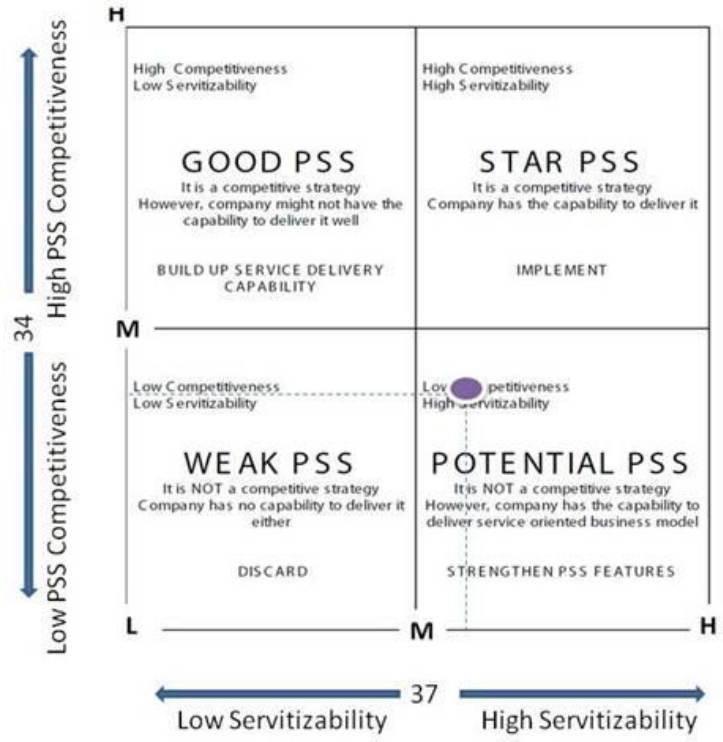
11

Structure	11	28%
Infrastructure	32	89%
Overall Score	43	59%
Servitizability	High	

The PSSe Methodology 2010

Stage 7: Determine Type of PSS Strategy

The last stage of the PSSE methodology consolidates the outcomes and generates the final PSS competitiveness score card by using the PSS Competitiveness Assessment Matrix (PSS-CAM). The final results produced for Semi-con Equipment Co. are as follows:



The proposed new PSS is identified as a POTENTIAL PSS competitive strategy. Although the company generally possesses capability in delivery the new PSS strategy, the competitiveness of the new PSS strategy is rather low. PSS competitive elements such as Cost, Flexibility, Delivery and Customer Satisfaction have scored 0 or negative. The company needs to improve on all these elements before it can start to consider adopting the new PSS strategy.

Case Study's Report Semi-Con Equipment Co.

S4

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Work Sheet 7.1: PSSE Report Card and Future Actions

TYPE OF PSS MODEL PROPOSED	Result Oriented PSS Selling inspection of wire bond by using 3rd optical inspection machine.
LEVEL OF PSS COMPETITIVENSS	**L** **H**
LEVEL OF SERVITIZABILITY	**L** **H**
TYPE OF PSS STRATEGY AFTER ASSESSMENT	**GOOD PSS** **STAR PSS** **WEAK PSS** **POTENTIAL PSS**
CRTICAL RESOURCES REQUIRED TO IMPLEMENT NEW PSS STRATEGY	
FUTURE ACTION	✓ To improve on all the PSS elements that currently not competitive enough, especially in the area of Cost and Flexibility which have scored negatively in all its variables.

APPENDIX D: POST ASSESSMENT QUESTIONNAIRES & RESULTS

D1 Questionnaires for Methodology Assessment

(Adopted from Lim, 2007)

PART 1: FEASIBILITY

The purpose of Part I of the questionnaire is to find out whether the new PSSE methodology could be followed. Please tick the answer which correspond to your opinion, and feel free to comment if necessary. Your feedback is greatly appreciated. Thank you.

Q1.1. Consistency: Is the sequence of the stages of the PSSE methodology consistent?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q1.2. Completeness: Did the PSSE methodology provide complete analysis and evaluation process of the intended purpose?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q1.3. Contingency: If any of the stages in the PSSE methodology encountered problems, did the methodology provide an alternative solution?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q1.4. Applicability: Do you think that the PSSE methodology can be applied satisfactorily in evaluating the competitiveness of your new PSS strategy?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q1.5. Overall Comments on the Feasibility of the Methodology, if any:

PART 2: USEFULNESS OF THE PSSE METHODOLOGY

The purpose of Part 2 of the questionnaire is to find out whether the PSSE methodology provides useful results that met the user's expectation. Please tick the answer which correspond to your opinion in each question, and feel free to comment if necessary. Your feedback is greatly appreciated. Thank you

Q2.1. Effectiveness: Did the final results produced meet your expectation?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.2. Contribution: Did the PSSE methodology contribute any useful knowledge?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.3. Efficiency: Did the PSSE methodology consume excessive resources of time and people?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.4. Success: Did the PSSE methodology provide successful result?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.5. Practicality: Are the stages and worksheet provided practical and useful?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.6. Satisfaction: Would you use the methodology again in your organisation?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q2.7 Overall Comments on the usefulness of the methodology, if any:

PART 3: USABILITY

The purpose of Part 3 of the questionnaire is to find out how easy the new PSSE methodology could be followed. Please tick the answer which correspond to your opinion, and feel free to comment if necessary. Your feedback is greatly appreciated. Thank you.

Q3.1. Time: How long did the methodology take?

Man-day efforts:

Did the timing of the methodology fit into your work schedule?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q3.2. Ease of use: Did you find the tools and worksheet provided at each stage reasonably easy to follow and use?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q3.3. Understanding: Were the aims and actions of the methodology clear at each stage?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q3.4. Flexibility: Did the methodology provide you flexibility in the use?

No/Not at all ☐ Partly ☐ Don't know ☐ Mostly ☐ Yes ☐

Q3.5 Overall Comments on the Usability of the Methodology, if any:

PART 4: FEEDBACK FOR FURTHER MODIFICATION OF THE METHODOLOGY

The purpose of Part 4 of the questionnaire is to find out whether the new PSSE methodology needs to be modified. Please feel free to comment. Your feedback is greatly appreciated and shall be used for future improvement of this methodology. Thank you.

4.1. What are the strengths and weaknesses of the methodology?

4.2. What changes would you like to make if you would use the methodology again?

4.3. Are there any stages in the methodology that you would like to modify or combine?

4.4. Please list the most and least useful stages of the PSSE methodology:

PART 5: OVERALL SUCCESS RATING

5.1. Please rate the success of the overall process of the PSSE methodology.

- Very successful ☐
- Successful (worth doing) ☐
- Most unsuccessful (waste of time) ☐
- Not successful (not worth doing) ☐

Don't know ☐

Final Comment, if any:

PART 6: FINAL REMARKS (TO BE FILLED BY THE RESEARCHER OR FACILITATOR)

Feasibility of the PSSE Methodology:

Usefulness of the PSSE Methodology:

Usability of the PSSE Methodology:

D2 Results of Primary Evaluation

CASE P1: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
Water Heater Co.

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Success	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Successful (worth doing)

CASE P1: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS
Water Heater Co.

RESULT OF FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	4	2	3		3.0
Completeness	3	3	3		3.0
Contingency	2	2	3		2.3
Applicability	3	4	5		4.0
					61.7%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	4	4	3		3.7
Contribution	5	4	3		4.0
Efficiency	4	4	4		4.0
Practicality	2	4	3		3.0
Usefulness	2	5	2		3.0
Satisfaction	3	4	2		3.0
					68.9%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	4	3	4		3.7
Time	5	4	3		4.0
Understanding	4	3	4		3.7
Flexibility	3	4	2		3.0
					71.7%

OVERALL AVERAGE RATING

67.4%

CASE P2: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
CAD CAM Controller Co.

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Usefulness	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Very successful

CASE P2: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS
CAD CAM Controller Co.

RESULT OF FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	4	5			4.5
Completeness	5	3			4.0
Contingency	4	2			3.0
Applicability	3	4			3.5
					75.0%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	4	4			4.0
Contribution	5	4			4.5
Efficiency	3	2			2.5
Practicality	3	4			3.5
Usefulness	4	5			4.5
Satisfaction	3	4			3.5
					75.0%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	5	5			5.0
Time	2	2			2.0
Understanding	4	5			4.5
Flexibility	3	2			2.5
					70.0%

OVERALL AVERAGE RATING

73.3%

D3 Results of Secondary Evaluation

CASE S1: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
Partial Discharge Analyser
Facilitator: Certified Facilitator

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Usefulness	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Successful (worth doing)

CASE S1: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS
Partial Discharge Analyser

RESULT OF FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	4	5			4.5
Completeness	4	3			3.5
Contingency	4	3			3.5
Applicability	3	4			3.5
					75.0%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	5	5			5.0
Contribution	3	4			3.5
Efficiency	4	5			4.5
Practicality	5	4			4.5
Usefulness	3	4			3.5
Satisfaction	3	4			3.5
					81.7%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	3	4			3.5
Time	5	4			4.5
Understanding	3	3			3.0
Flexibility	3	4			3.5
					72.5%

OVERALL AVERAGE RATING

75.2%

CASE S2: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
Beauty Machine Co.
Facilitator: Untrained Facilitator

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Usefulness	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Successful (worth doing)

CASE S2: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS
Beauty Machine Co.

RESULT OF FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	2	5	4		3.7
Completeness	4	3	3		3.3
Contingency	4	4	4		4.0
Applicability	3	4	3		3.3
					71.7%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	5	5	5		5.0
Contribution	3	4	4		3.7
Efficiency	4	4	4		4.0
Practicality	2	4	4		3.3
Usefulness	3	4	4		3.7
Satisfaction	2	4	4		3.3
					76.7%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	2	4	3		3.0
Time	5	4	5		4.7
Understanding	5	3	5		4.3
Flexibility	2	4	3		3.0
					75.0%

OVERALL AVERAGE RATING

74.4

CASE S3: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
Facilitator: Participating Company

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Usefulness	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Successful (worth doing)

CASE S3: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS

RESULT OF FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	4	5			4.5
Completeness	4	3			3.5
Contingency	4	4			4.0
Applicability	3	4			3.5
					77.5%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	5	5			5.0
Contribution	3	4			3.5
Efficiency	4	4			4.0
Practicality	5	4			4.5
Usefulness	3	4			3.5
Satisfaction	3	4			3.5
					80.0%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	3	4			3.5
Time	5	4			4.5
Understanding	5	3			4.0
Flexibility	3	4			3.5
					77.5%

OVERALL AVERAGE RATING

78.3%

CASE S4: FACILITATOR'S POST WORKSHOP ASSESSMENT RESULTS
Semi-con Equipment Co.
Facilitator: Certified Facilitator

RESULT OF FEASIBILITY ASSESSMENT

	Feasibility Criteria	Score
Q1.1	Consistency	5
Q1.2	Completeness	4
Q1.3	Contingency	4
Q1.4	Applicability	5
		Very Good

RESULT OF USEFULNESS ASSESSMENT

	Usefulness Criteria	Score
Q2.1	Effectiveness	5
Q2.2	Contribution	4
Q2.3	Efficiency	3
Q2.4	Practicality	2
Q2.5	Usefulness	4
Q2.6	Satisfaction	5
		Good

RESULT OF USABILITY ASSESSMENT

	Usability Criteria	Score
Q3.1	Ease of Use	2
Q3.2	Time	2
Q3.3	Understanding	2
Q3.4	Flexibility	5
		Good

OVERALL RATING

Successful (worth doing)

CASE S4: PARTICIPANT'S POST WORKSHOP ASSESSMENT RESULTS
Semi-con Equipment Co.

FEASIBILITY ASSESSMENT

Feasibility Criteria	P1	P2	P3	P4	Average Score
Consistency	5	5			5.0
Completeness	4	3			3.5
Contingency	4	4			4.0
Applicability	3	4			3.5
					80.0%

RESULT OF USEFULNESS ASSESSMENT

Usefulness Criteria	P1	P2	P3	P4	Average Score
Effectiveness	5	5			5.0
Contribution	3	4			3.5
Efficiency	4	4			4.0
Practicality	3	4			3.5
Usefulness	3	4			3.5
Satisfaction	5	4			4.5
					80.0%

RESULT OF USABILITY ASSESSMENT

Usability Criteria	P1	P2	P3	P4	Average Score
Ease of Use	4	4			4.0
Time	5	4			4.5
Understanding	5	3			4.0
Flexibility	4	4			4.0
					82.5%

OVERALL AVERAGE RATING

80.8%

End of Thesis